ATLANTIC FISHERIES
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Fisheries and Oceans | Pêches et Océans

87-01810/

ATLANTIC CANADA SURIMI WORKSHOP

Clarenville, Newfoundland
January 28-30, 1987

SPONSORED BY:
The Atlantic Fisheries Technology Program (AFTP)
Department of Fisheries and Oceans

PROCEEDINGS

General Education Series #4

Également disponible en français

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DFO/3460

Cat. No. Fs 68-2/1-4E
ISBN 0-662-15242-5

Correct citation for this publication:

ROACHE, J.F.(ED.). 1987 Atlantic Canada Surimi Workshop — Proceedings. General Education Series #4; 204p.

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PROCEEDINGS

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ABSTRACT

Roache, J. F. (ED.). 1987. Atlantic Canada Surimi Workshop - Proceedings. General Education Series # 4: 204 p.

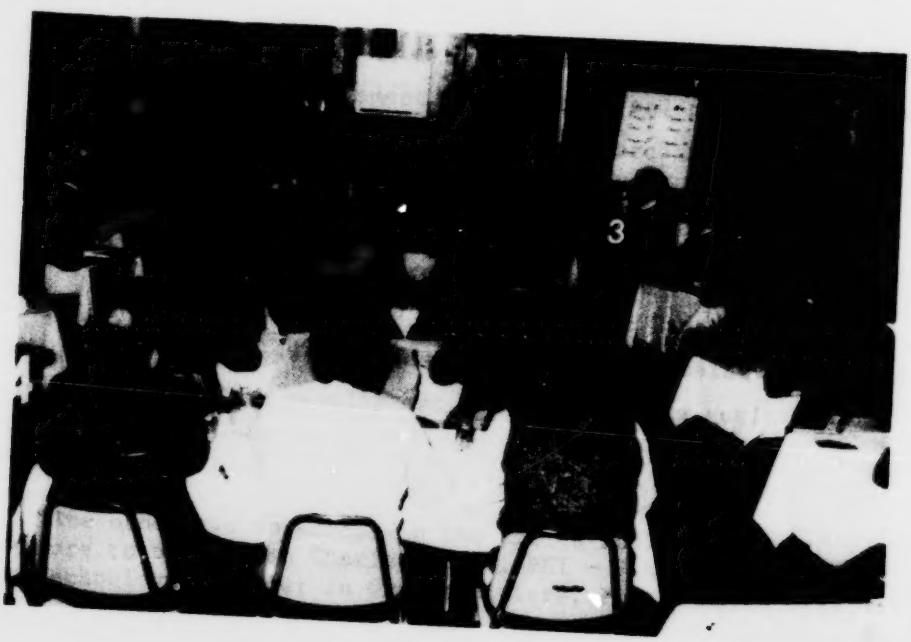
This publication contains the proceedings of the Atlantic Canada Surimi Workshop held in Clarenville, Newfoundland, January 28-30, 1987. Sponsored under the Atlantic Fisheries Development Program of the Department of Fisheries and Oceans, the Workshop brought together by invitation approximately 75 resource persons and participants representing two levels of government (federal and provincial), industry and several research institutes from across the region. While the fundamental purpose of the Workshop was to serve as a technology transfer exercise, an equally important objective was to develop a consensus among participants concerning the future direction of research and development and related initiatives within this sector of the fishing industry.

RESUME

Roache, J.F. (ED). 1987. Conférence sur le Surimi, Région Atlantique du Canada. Education générale. Série no.4: 204p.

Cette publication comprend les Actes de la Conférence sur le Surimi, Région Atlantique du Canada, qui s'est tenue à Clarenville, Terre-Neuve du 28 au 30 janvier 1987. Parrainée par le programme de technologie des pêches de l'Atlantique, Ministère des Pêches et Océans, la conférence a réuni sur invitation environ 75 experts et participants représentant deux niveaux du gouvernement (fédéral et provincial), l'industrie et les instituts de recherche de la région. Tandis que l'objectif principal de la conférence a consisté en un exercice de mutation technologique, un autre, d'égale importance, a visé l'établissement d'un accord parmi les participants en ce qui concerne l'orientation future de la recherche et du développement ainsi que des initiatives connexes au sein de ce secteur de l'industrie des pêches.

Seventy-five representatives of government, industry and research institutes from Ottawa and the five eastern provinces participating in the Atlantic Canada Surimi Workshop in Clarenville, Newfoundland January 28-30, 1987.



INTRODUCTION

On January 28-30, 1987, the Department of Fisheries and Oceans, in cooperation with the Extension Service of Memorial University of Newfoundland, hosted an Atlantic-wide, industry-government Workshop on Surimi (fish analog product) Development. One of a series of three such workshops to be funded under the Department's Atlantic Fisheries Development Program during the first quarter of 1987, it brought together by invitation approximately 75 delegates from the primary and secondary sectors of the fishery, the research institutions, and both levels of government - federal and provincial.

In announcing the Workshop, Fisheries and Oceans Minister, Tom Siddon said, "An initiative of this size and scope reflects my commitment to the development of the surimi industry in Atlantic Canada. In addition, my department, through its Atlantic Fisheries Development Program, has in recent years invested almost a million dollars in surimi development throughout the region." Mr. Siddon explained further that "To effectively develop surimi to the extent that we would like will require the involvement, cooperation and commitment of other departments of government, the provinces, research institutions and, most importantly perhaps, the private sector."

Each of these key groups was represented among the presenters and delegates invited to participate in the Atlantic Canada Surimi Workshop. As such, it was an ideal forum for the positive interaction required for the future development of the fledgling surimi industry to occur.

*Note: The other two workshops in the series include one on Aquaculture to be held in Charlottetown, PEI - February 9/12, 1987 and one on Technology Transfer in Grande Riviere, P.Q. - March 9/11, 1987.

Included in the Agenda (Appendix A) were presentations providing:

- an international perspective (markets; economics; and technology)
- current industry status - Atlantic Canada (raw material availability, acceptability and applicability; flavouring; technology; and marketing)
- the regulatory background; and
- the producers' perspective (problems and opportunities).

The Workshop was chaired by Frank Slade, former Director of Development, Fisheries and Oceans, Newfoundland Region and featured a guided tour for participants of the Terra Nova Fishery Company Surimi Plant in Clarenville, hosted by its President, Dr. Cosmas Ho (Appendix B). By its conclusion on Friday, January 30, a clear sense of direction had developed among participants about the action required to ensure the future success of the industry in Atlantic Canada. Everyone seemed more committed to seizing the obvious opportunity to develop this new segment of the fishery by adequately addressing the problem areas identified in the working sessions.

Consensus seemed to centre around the advancement of processing technqlogy as a first priority. Perhaps because of the stage of evolution at which the industry finds itself, the closely related alternatives of product development and additional raw material research were ranked second and third in priority by workshop participants as the industry now shifts its attention from surimi itself to surimi-based products. The successful production of both requires the use of flavorings, and the groups ranked this work as next in importance. At the bottom of the list of priorities, but still considered important, were regulations and environmental impact. And so, a clear pattern concerning the future direction of surimi-related research and development has begun to emerge.

These proceedings are intended to record and reflect the process of technology transfer as it occurred at the Atlantic Canada Surimi Workshop in Clarenville, Newfoundland, January 28-30, 1987. Those who attended and those with a strong interest in the development of a surimi industry should find within these pages information of considerable practical importance to their efforts to participate in and profit by their involvement in this new segment of the east coast fishery.

Chairman's Opening Remarks

by

Frank Slade
Director, Harbours and Infrastructure
Department of Fisheries and Oceans
St. John's, Newfoundland

Honoured guests, ladies and gentlemen, welcome to the Atlantic Canada Surimi Workshop. We hope the next couple of days will be informative and enjoyable. This workshop is the first in a series of three, sponsored by the Atlantic Fisheries Technology Program, Department of Fisheries and Oceans. An Aquaculture Workshop is to be held at Holland College, Charlottetown, Prince Edward Island, in February and a Technology Transfer Workshop is scheduled for Grande Rivieres, Quebec, in March.

These three workshops are designed to facilitate communication among government, industry and research institutions. We hope the exchange of information and ideas which ensues will provide direction for meaningful future work.

For those who are unfamiliar with the term, **surimi** is a bland tasting, odourless fish protein paste that, when heated, forms a firm, elastic gel. It is made by mechanically deboning fish and putting it through a series of wash cycles. The washed fish meat is then dehydrated to approximately 79%-80% moisture, and a mixture of sugar, sorbitol or dextrose and polyphosphates is added to protect its gelling properties when frozen. Surimi forms the base for a variety of processed foods, such as seafood analogs and sausage. It may be used as a texturizer or binder in protein foods and as an extender or high protein supplement in meat products.

Surimi originated in Japan nearly 600 years ago. It began as a method to preserve fish for short periods of time. The process was mechanized

in 1960, and today is a major industry in Japan. Most surimi is processed from Alaskan Pollock, but, as you will hear from the speakers yet to come, a variety of other species have been identified as possible sources of raw material. For example, Terra Nova Fishery has been using trap cod as the raw material for imitation crabsticks.

At this time, Japan is the world leader in surimi marketing and technology, but because of the potential surimi represents, other countries are examining its potential for development. The growth of the analog market, the versatility of fish protein and the potential of utilizing currently discarded species and processing plant by-products are three of many factors that make the prospects for the development of an Atlantic Canada surimi industry so exciting.

In 1984, Dr. Ho of Terra Nova Fishery here in Newfoundland established the first surimi producing plant in Canada and the first ever to use cod as the main raw material. Considerable interest was generated with respect to the potential for surimi production, the process involved and the technologies required.

During the same year, the Development Branch of the Newfoundland Region of the Department of Fisheries and Oceans commissioned a study to determine the potential for a surimi industry in Atlantic Canada and the extent to which we as government should become involved in the development of a surimi industry. The study was conducted by Tavel Limited of Nova Scotia. Copies have since been distributed widely and are available here in the display area.

Immediately following receipt of the Tavel report, an Atlantic Surimi Development Committee was established and a structured development program was initiated.

In 1985, the Newfoundland and Labrador Institute of Fisheries and Marine Technology was contracted by DFO in Newfoundland to investigate

the raw material suitability of selected underutilized species. The Bibun surimi pilot line was installed and a surimi quality testing laboratory was set up. Memorial University was subcontracted by the Marine Institute to investigate the possible use of crab processing offal as a source of natural flavouring for crab flavored extracts and the effect that actomyosin viscosity has on quality of surimi.

At the same time, the Technical University of Nova Scotia was contracted by the Development Branches of Fisheries and Oceans in the Nova Scotia and Gulf regions to investigate the suitability of herring, hake and dogfish for use in surimi. In 1986, work continued on the acceptability of raw material, the adaptation of processing procedures and equipment to handle various types of raw material, and flavour development. CANPOLAR Consultants was contracted by DFO in the Newfoundland and Gulf regions to develop process controls for surimi equipment now in use.

During this workshop, we hope to present you with an international perspective on surimi development through presentations by Sharon Gwinn, Acting Director of the Alaska Fisheries Development Foundation and Geir Sobstad of Alfa-Laval, Soborg, Denmark. Sharon will talk about market and economic prospects. Geir will discuss advances in surimi processing equipment and technology. From there, we'll have a look at what has transpired in Atlantic Canada.

At the federal level, we first became interested in surimi as a means of utilizing raw material that was landed and later discarded. Trap fish (small cod) and male capelin in Newfoundland, herring in Nova Scotia and groundfish frames throughout Atlantic Canada were the major areas of concern. By no means, however, do we want to limit surimi production to existing landings. The possibility of using fish resources now not utilized by Canada, as well as those which are underutilized, must also be considered.

In order to give us a better appreciation of the resource side of the surimi equation, Max Grandy of the Economics Branch, DFO, Newfoundland region will give us an overview of raw material availability.

During the past two years, research has been conducted at the Newfoundland and Labrador Institute of Fisheries and Marine Technology (Marine Institute) and at the Technical University of Nova Scotia (TUNS) to determine the acceptability of various underutilized fish species and plant by-products for surimi production. Richard Whitaker and Chandra Chinniah of the Marine Institute and Richard Ablett of TUNS are here today to present developments to date.

Ernie Reimer and Mike Hawco of CANPOLAR Consultants will speak to us on processing concerns. Mike Voigt (MUN) will give us a rundown of flavour development work he has been doing, and Robert Mills of the Department of Fisheries and Oceans will present the regulatory situation as it affects surimi processing in Canada.

Tomorrow, Dr. Ho of Terra Nova Fishery will give us an account of how he got started in surimi production and the problems he encountered in setting up his surimi operation.

International Perspective:
Market and Economic Situation
by
Sharon Gwinn
Alaska Fisheries Development Foundation

For the last six years, I have worked at the Alaska Fisheries Development Foundation, which is a non-profit organization of fishermen and seafood processors that has nursed the infant Alaska surimi industry into being, (using some federal grant money and a great deal of undaunted human energy).

I want to thank our hosts for inviting me to speak, and for doing such a fine job of assembling this group. Almost ten years ago, I had the privilege of seeing much of Newfoundland's coastline from aboard a square-rigged sailing ship, and ever since then I have looked forward to a return visit.

The purpose of my presentation today is to outline, from an international perspective, the size and shape of the surimi industry, highlighting some of the important trends in its recent history. I will emphasize observations that I think will help Canadian business people evaluate their opportunities in the industry. There are always opportunities, some more obscure than others, in any industry that is growing and changing as rapidly as this one is.

I think my experience from Alaska may be useful to you, because our seafood industries share some fundamental characteristics. Probably the most significant is our almost complete reliance on export markets. In Alaska, our definition of "export" is sending goods to any destination outside the state, since shipping to Seattle often costs as much, and is just as cumbersome, as shipping to a foreign nation.

Other characteristics we share are the general distribution pattern of our population, the often remote sites of production with meager support facilities, and the critical importance of seafood to our state's economy. Since the oil "boom" is now history in Alaska, we look to our fishery resources for our economic salvation. And, like Atlantic Canada, in some cases, we must compete with foreign interests to utilize those resources.

There are also contrasts between our two industries that I believe will give you advantages as you move to develop a surimi industry here. First, your seafood processing enterprises are not owned by Japanese fishing companies, as ours often are, and second, your industry is vertically integrated and will lend itself to tight quality control, which is essential when trying to establish a foothold in a new marketplace.

Before I present some facts about the worldwide surimi industry, it is important to clarify terminology. I will distinguish **surimi**, the raw material, from surimi-based products, one example of which is the simulated crab product you saw being made yesterday (during a tour of Terra Nova Fishery). It is important to make this distinction so that we can discuss production economics, even though, in the minds of American consumers, the word "surimi" means "imitation crab".

Table 1 illustrates the surimi process. There are three important economic factors apparent from the flow chart. First, note that the surimi process requires large amounts of fresh water. Second, note the variety and quantity of by-products. Third, you can see that the final yield of surimi from round fish weight is only about 22%.

Table 1

Surimi Process Flow

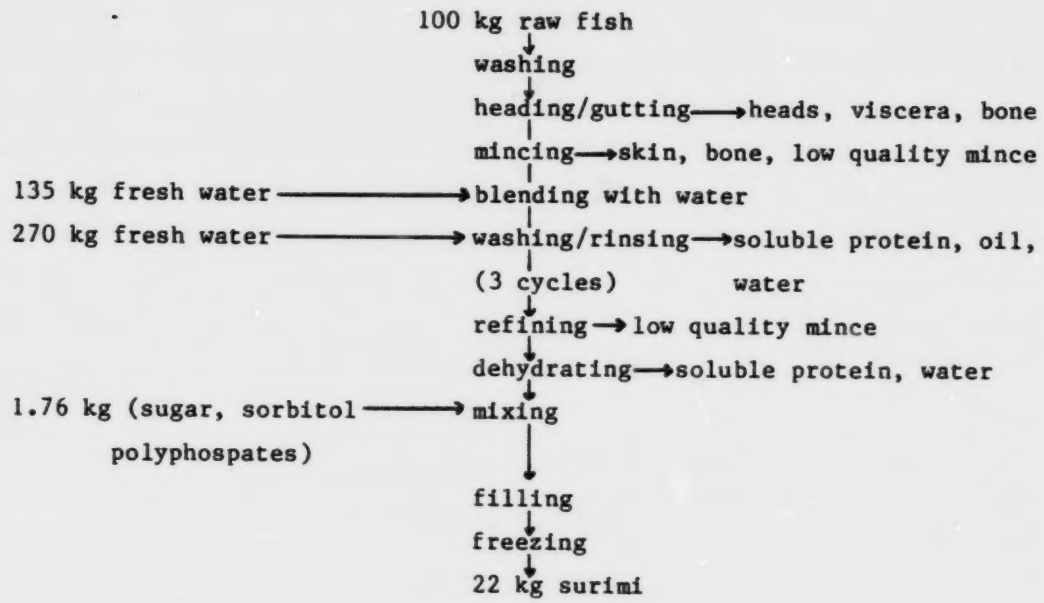


Table 2 provides a sample recipe for imitation crab made with surimi. This formulation contains a lower than average percentage of surimi, and yet the surimi represents more than 75% of raw material cost to the processor. You can see that there is water added to the surimi as well as other ingredients. High quality surimi will absorb and hold much more water than low quality surimi. This is often the most important consideration for the secondary processor in buying surimi, since the highest quality product will usually be twice as costly as the lowest quality. Right now, the highest quality surimi costs about $1.50 a pound, with a moisture content of about 75%, which makes it a very expensive protein material.

Table 2

Example Formulation—Imitation Crab

Ingredient	Percentage by Weight	Percentage by Value
Pollock	49.5	75.7
Water	31.6	---
Potato Starch	6.9	5.2
Egg White	5.0	5.1
Salt	1.6	0.4
Crab Flavour	0.3	2.8
Sugar	1.5	1.2
Sweet Rice Wine	1.7	4.4
MSG	0.6	1.4
Coloring	0.4	1.0
Inosinic Acid	0.9	2.6

In a sense, the term "international" when applied to the surimi industry is misleading. Japan was the cradle, centuries ago, of the surimi industry, and Japanese companies are responsible for most of the developments occurring around the world in recent years.

Table 3 presents an outline of the Japanese surimi and surimi-based products industry. Since Japan produces more than 95% of the world's total in both categories, Japan by itself represents "international" production.

Modern surimi production began in Japan in 1960 and reached the level of about 350,000 MT annually by 1972, with 19 factory ships and 105 land plants operating. Since then, total annual production has remained in the range of 350,000 to 400,000 MT. More than half of the total is made at sea, and is considered so much better in quality that ship-processed surimi is graded by a different system than that used

for shore-processed surimi. The factory trawler and mothership fleet has grown to about 25 vessels, while the number of operating land plants has declined to about 60. While total production volume has remained fairly steady, the species composition of the catch for surimi manufacture has changed in recent years. With their access to Alaska pollock beginning to be curtailed, the Japanese have put a great deal of work into technology for making surimi from high-fat species such as sardines and mackerel.

Table 3

Surimi Production

1981	306,657 metric tonnes
1982	340,535 metric tonnes
1983	340,000 metric tonnes
1984	407,758 metric tonnes

Surimi-Based Products

Total	approx. 980,000 metric tonnes
approx. 840,000 MT	"Kamaboko"
approx. 100,000 MT	fish ham/sausage
approx. 44,000 MT	imitation crab ('83)

Exports

Surimi	approx. 17,000 metric tonnes
Kamaboko	approx. 60,000 metric tonnes
	mostly imitation crab
	mostly to U.S.

Imports

Quota System

U.S. over-the-side sales

Thailand croaker surimi

New Zealand hoki

Other Exports

Technology

Annual volumes of surimi-based products in Japan total about 980,000 metric tonnes and include hundreds of different product forms. The

largest group is "kamaboko", constituting about 840,000 MT and further classified among several groups of products, depending upon the cooking method, which can be steaming, frying or broiling. A second category, fish ham and sausage, accounts for about 100,000 MT of the total, but Japanese consumption in this category has been declining slightly in recent years. The decline has been offset by growth in production and consumption of "other surimi-based products" (over 70,000 MT), a category comprising mostly imitation crab. These shellfish analogs were developed in the early 1970s in Japan and now are exported to more than twenty different countries on all the continents. In fact, imitation crab is credited with making surimi an international business.

Japanese exports of surimi, the raw material for all of these varied products, have reached more than 15,000 MT annually, up from about 600 MT five years ago. Exports of imitation crab in 1986 totalled more than 60,000 MT, up from 400 MT in 1978, and 9,000 MT in 1982. The United States is the destination for 90 to 95 per cent of all of these exports. In 1978, only 2% of the total production of imitation crab was exported; by 1985, the export portion was greater than 50%. Clearly, Japan relies for the growth of its surimi industry on the expanding U.S. market for imitation crab.

Imports of surimi into Japan are not very significant, and are subject to a very complex, restrictive quota system. They are mostly composed of specialized surimi of very high quality such as that made from croaker in Thailand and, more recently, from hoki in New Zealand. There is no importation of finished surimi-based products into Japan - that I know of. In recent months as Korean companies have begun aggressively competing with Japanese surimi, the Japanese companies have been buying Korean surimi just to take it off the market. One important supply of surimi to Japan that probably should be categorized as an import is the product of over-the-side sales of Alaska pollock from American fishermen to Japanese processing ships,

transferred at sea off Alaska. The pollock allocation for these "joint venture processing (JVP)" agreements is set by the U.S. Secretary of Commerce on the advice of the North Pacific Fishery Management Council. This year the JVP allocation will probably be set at just over 1,000,000 MT of pollock, translating into more than 200,000 MT of surimi. The joint ventures provide more than a third of Japan's pollock supply. They also employ most of Alaska's groundfish trawler fleet, discouraging those fishermen from engaging in the extra effort required to deliver to an American shore plant.

The surimi industry is becoming international very quickly, with surimi and imitation crab plants proliferating in the U.S., the Faroe Islands, Scotland and South America. Most of this development is financed by Japanese companies, often as a means of maintaining their access to raw material for surimi or to the surimi itself.

There are now fourteen imitation crab plants in the United States, two of which are located on the east coast. Only a few of these plants are American-owned; the rest are either joint ventures between Japanese fishing companies and American seafood processors, or wholly owned subsidiaries of Japanese fishing or kamaboko companies. Total production capacity of all these plants is about 40 million pounds, which would supply about a third of the U.S. market today. Actual production of imitation crab in the U.S. last year was probably not more than 30 million pounds. None of this production occurs in Alaska. It is not a place where many finished products of any kind are produced, although that may change as our labour costs come down in the current Alaska recession.

Alaska now boasts three operating surimi plants on shore, plus one at sea, with several other floating processors and factory trawlers to begin processing during the next year. Ironically, the new at-sea operations are U.S.-owned companies, while the shore plants are joint ventures or subsidiaries of Japanese companies. Total present

production capacity for surimi is about 15,000 MT. This newly commissioned American capacity is more than matched by South Korean surimi processing ships recently deployed in the joint venture mode off Alaska.

The growth market for surimi and surimi-based products is the United States. Per capita consumption of seafood has leaped ahead the last two years, to more than 14 pounds edible weight. It continues to grow even though the spread in consumer prices between fish and meat and poultry continues to widen. Furthermore, U.S. consumers are no strangers to imported seafood; we already import more than 60% of consumption.

The U.S. seafood industry does not spend a great deal of money on marketing and promotion. The dramatic growth of imitation crab sales is probably due to the fact that the product eliminates all of the negative attributes of seafood according to American consumers. It doesn't smell fishy, it's easy to prepare or requires no preparation, and it contains no bones.

Though imitation crab is a great success story and it has stimulated the development of our surimi industry in Alaska, it has probably been even more beneficial to the Japanese fishing companies. Now that imitation crab sales are levelling off and U.S. consumers are familiar with surimi, we do have a vast opportunity to benefit our own seafood industry. The key to this opportunity is the "second generation" surimi-based products; processed meats, surimi nuggets, and blends of surimi with other meats and functional ingredients are some obvious examples.

The difficult part of developing these products and accessing this market potential will be economics. Important issues will be access to raw material; technology for making surimi from new species of fish; good marketing strategy that matches products to market niches; and

above all, good market information and the ability to analyze and use it. I think there are some excellent opportunities for American and Canadian enterprises to develop these U.S. markets co-operatively to the benefit of our respective seafood industries.

Recent Technological Advances in the Surimi Industry

by

Geir Søbstad/Tomas Zetterling

Alfa-Laval Fish and Meat Engineering A/S

Maskinvej 5, DK-2860 Soborg (Copenhagen), Denmark

The research and development work described in this paper was conducted under invitation from and with the co-operation of the Alaska Fisheries Development Foundation (AFDF) as part of a project to develop a surimi process for the U.S. fishing industry.

In 1984, AFDF bought a surimi plant with a capacity of 2,600 lbs./hr. and installed it at the Alaska Pacific Seafood factory in Kodiak, Alaska.

The main aim was to develop a U.S. industry centered on the utilization of Alaska Pollock (Theragra Chalcogramma) (anon; 1985). A related objective of the work at Kodiak was to develop a process which was efficient and reliable.

As losses of suspended solids in the wash and press water in a conventional surimi plant may be as high as 35% of the raw material entering the wash stage, it was considered to be of great importance to recover as much of it as possible in order to increase yield (Fig. 1).

The principle behind the surimi plant was the washing of minced fillets in tanks and the draining off of water through three rotary screens (Fig. 1). The effluent from the three screens was collected and sent down the drain. From the third screen, washed mince was sent to the refiner and the refined material to the press, after which the cryoprotectants were added and the surimi frozen (Suzuki, T., 1981).

Use of Decanter Centrifuges in the Surimi Processing Industry

The decanter centrifuge is one of many different types of centrifuges where centrifugal acceleration is used for separation. Today decanter centrifuges are commonly used in industrial applications for continuous separation of solids from liquid suspensions (Fig. 2).

The basic idea of using the decanter in the surimi processing is not new, but, so far, there have been no reports of successful applications in this area. The development of a new surimi processing line thus represented a new application to Alfa-Laval.

The centrifuge operates on the principle of an increased g-force created by a rotating cylinder, i.e., the machine will greatly improve the separation of particles as long as there exists a difference in density between particle and solvent.

Generally, the sedimentation of particles will follow Stokes' law:

$$V_a = \frac{dp^2 \cdot (\rho_p - \rho_l)}{18\,\mu} \cdot g \qquad (1)$$

where V_a = actual setting velocity (m/s)
dp = particle diameter (m)
g = gravitational acceleration (m/s^2)
ρ_p = particle density (kg/m^3)
ρ_l = liquid density (kg/m^3)
μ = dynamic viscosity (kg/m^3)

If the separation is taking place in a settling tank, g is equal to gravitational acceleration on earth (9.81 m/s^2).

Using a decanter will increase the g-force and thus the sedimentation velocity:

$$V_1 = \frac{d_p \cdot (\rho_p - \rho_1)}{18\mu} \cdot g \cdot \frac{rw^2}{g} \qquad (2)$$

where rw_2 = Relative centrifugal force (RCF).

Substituting equation 1 in 2, we have:

$$V_1 = V_o \cdot \frac{rw^2}{g} \qquad (3)$$

In the rotating cylinder, with liquid volume = V, the particle will migrate a distance L in a time t:

$$L = V \cdot t \qquad (4)$$

The residence time of the particle in the decanter depends on the flow of liquid through the decanter:

$$t = \frac{V}{Q} \qquad (5)$$

We can re-arrange 3, combining with 4 and 5 to produce:

$$L = V_o \cdot \frac{rw^2}{g} \cdot \frac{V}{Q} \qquad (6)$$

or, expressed by capacity:

$$Q = V_o \cdot \frac{rw^2 \cdot V}{g \cdot L} = V_o \cdot \Sigma \qquad (7)$$

This formula tells us that the decanter can clean the liquid from a certain type of particle to a certain capacity per hour, depending on the sedimentation characteristics of the particle, V_o, and a performance factor for the decanter, Σ . Thus, to be able to

thoroughly clean the liquid, one has to work at influencing the Σ - factor of the machine (Aiba, S. et al, 1973).

Equipment

Decanter MRNX 418B-31 in sanitary design with turnmotor and CIP-system (including spray nozzles).
Conveyor 1 x 70 mm TM 11.
Rotodiff type 107DGV.
Pumps: Mono for transport of solids.
Crepaco: For pumping effluent from rotary screens.

The technical arrangement and the experimental set up are shown in Figure 3.

Raw Material

Tests were carried out with mince fillets from Alaska Pollock (Theragra Chalcogramma) prepared in the Baader 182 and deboned in Baader 695.

Experimental Findings

In this experiment the main object was to reduce the losses in the process water. From Figure 1 we establish that the losses in the process occur at two separate stages in the process 10 in water which drains from rotary screens and 2) in water which drains from the screw dehydrator.

The best way of recovering as much as possible of the suspended solids is to use the screen waste water to flush the press vessel and to collect the water stream in a stirring tank before feeding it to the

decanter centrifuge. This solution might seem complex, but it ensures a constant feed with a constant composition, and this is of greatest importance to the separation result desired in the decanter.

To reduce the amount of water, the effluent from the rotary screens was collected in tank A and pumped to the press to wash the solids into tank B. From tank B, the liquid was pumped to the decanter by a variable speed Crepaco pump (Sobstad, G., 1986).

The performance test on the effluent from the rotary screens and the press was conducted with a series of different feed rates and the corresponding samples of feed and effluent were collected and analyzed with respect to suspended solids. This was done at the National Marine Fisheries Service Laboratory in Kodiak and the results are plotted in Figure 4.

Results and Conclusions

From Figure 4 it can be seen that the decanter performs rather efficiently. Normal recovery from the waste water was around 70% in a range of 5 to 6 m^3 per hour (the normal amount of wash water from this particular plant).

However, there may still be room for improvement in these figures, even if the last 30% may be difficult to precipitate in a decanter. There are, obviously, several factors which will influence the precipitation process. One of these is the hydration time in the system. Longer holding time may be very unfavourable in this regard. This would increase the hydration and thus reduce the difference $(\rho_p - \rho_l)$ in V_2 (equation 2).

The amount of suspended solids in the wash water varies considerably, depending on such factors as fish age, fish type, mesh size, residence

time in the screens, speed and type of pump, etc. These factors also have an influence on the amount of suspended solids in the press water, but additional factors also have an impact; for example, dry matter content of the screen mince, speed and hole size of the refiner and, of course, the physical characteristics of the press.

Tests on the end-product confirm the quality of surimi recovered from waste water by the decanter. This will mean an extra yield of up to 16% (Grade A surimi).

(The value of the reduced pollution load on the surrounding environment is not discussed here.)

However, improvements in the conveyor system gave a recovery of more than 90% between 2 and 5 m^3 per hour in later experiments. These results can most probably be extended to the range 5 to 10 m^3 per hour, by adjusting the factors of the Σ - value of the machine.

Decanter Replacing Screens

One defect of the screen system is its limited ability to extract waste material from the solids. Fish is minced, but will still contain larger fragments, the diffusion rate of which is slow at the low temperature.

Small particles will allow a better extraction rate, but they cannot be recovered by the screens.

The decanter centrifuge, with its ability to recover small particles, allowed an efficient wash of small particles that also improved the wash of the mince.

Thus, the next step was to put the decanter in-line, behind a new washing system which would break the fish fragments into individual particles.

This was achieved using a static mixer followed by a holding cell to obtain sufficient contact time. The particles were then recovered in the decanter centrifuge, as indicated in Fig. 5.

Results

As indicated in Fig. 6, there was a recovery rate of more than 90% to just below 90% at a feed rate to the decanter of 5,000 to 10,000 lbs. per hour (Zetterling, T., 1986).

The retention time of the solids in the in-line washing system was approx. 2.5 min. and the water/mince ratio was 4 to 1.

Even with this in-line system the losses were very small compared to the traditional system. However, a natural question is whether this one-stage wash is as efficient as the three-stage wash.

Table 1

Effect of washing on the composition of minced pollock flesh

	Composition (%)			
	Moisture	**Protein**	**Lipid**	**Ash**
Conventional Washing				
Mince	82.88	16.20	0.60	1.06
Washed Mince				
1st wash	89.46	10.69	0.40	0.34
2nd wash	90.66	8.70	0.33	0.16
3rd wash	92.78	7.30	0.30	0.13
Refined solids	92.88	6.94	0.26	0.14
Dewatered solids	86.59	13.49	0.40	0.07
Alfa-Laval				
Mince	82.84	15.81	0.52	1.06
Washed mince	91.02	9.24	0.24	0.14
Refined solids	91.19	9.17	0.24	0.14
Dewatered solids	83.04	17.19	0.30	0.24

Table 1 gives an answer to this question. It shows how the lipids and ash are reduced during processing. Using lipids as an indicator for the washing operation shows that the extraction effect is at least as good with the in-line system. The higher content of ash is most probably a result of the high g-force precipitating more bone-fragments.

General Discussion

The technology for surimi production is relatively new. Several different approaches therefore may be used to find a reasonable process to satisfy the varying demands regarding product quality, including those concerning bacteriological standards. But there is also a demand

for technological solutions to problems including operation, automation and cleaning. The Alfa-Laval system is built around the decanter centrifuge, which, with its relatively small volume, allows a quick response to any change required of it, and its ability to dewater the washed mince continuously with low-level losses makes it well suited for continuous production.

In a conventional system a ratio tank is used to mix mince and water to the designed ratio; however, when a tank is used for this purpose, neither the water/mince ratio nor the retention time is well-defined. A portion of mince might be held in the tank for a long time, while most of the remainder of the mince continues to pass through. The same phenomenon occurs in the leaching tanks--some mince might be thus overwashed and hydrated, and this increases losses in the later stages.

The result of a small particle wash is also a lower water consumption rate and a shorter leaching time to achieve the same wash effect as in tanks and rotary screens. Thus a small particle wash is more efficient.

As the washed mince from the decanter contains a greater proportion of small particles (normally lost in the wash water) the demands on the screw press construction are higher. If a screw press of poor construction is used, the compression in the press decreases to the point at which no dewatering takes place. It should be noted that to control the process, the refining step is another operation which may be improved.

In general, the Alfa-Laval concept is designed to interchange some parts of the surimi process with other well-known and proven equipment from the food industry to create a new process which will suit western technology, and our concept of processing. It has taken some time to incorporate different machines to give an acceptable function and

yield, but we feel that we can now present a proven process (Fig. 7). Of course, there may still be room for further modifications and improvements.

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FIGURE 1

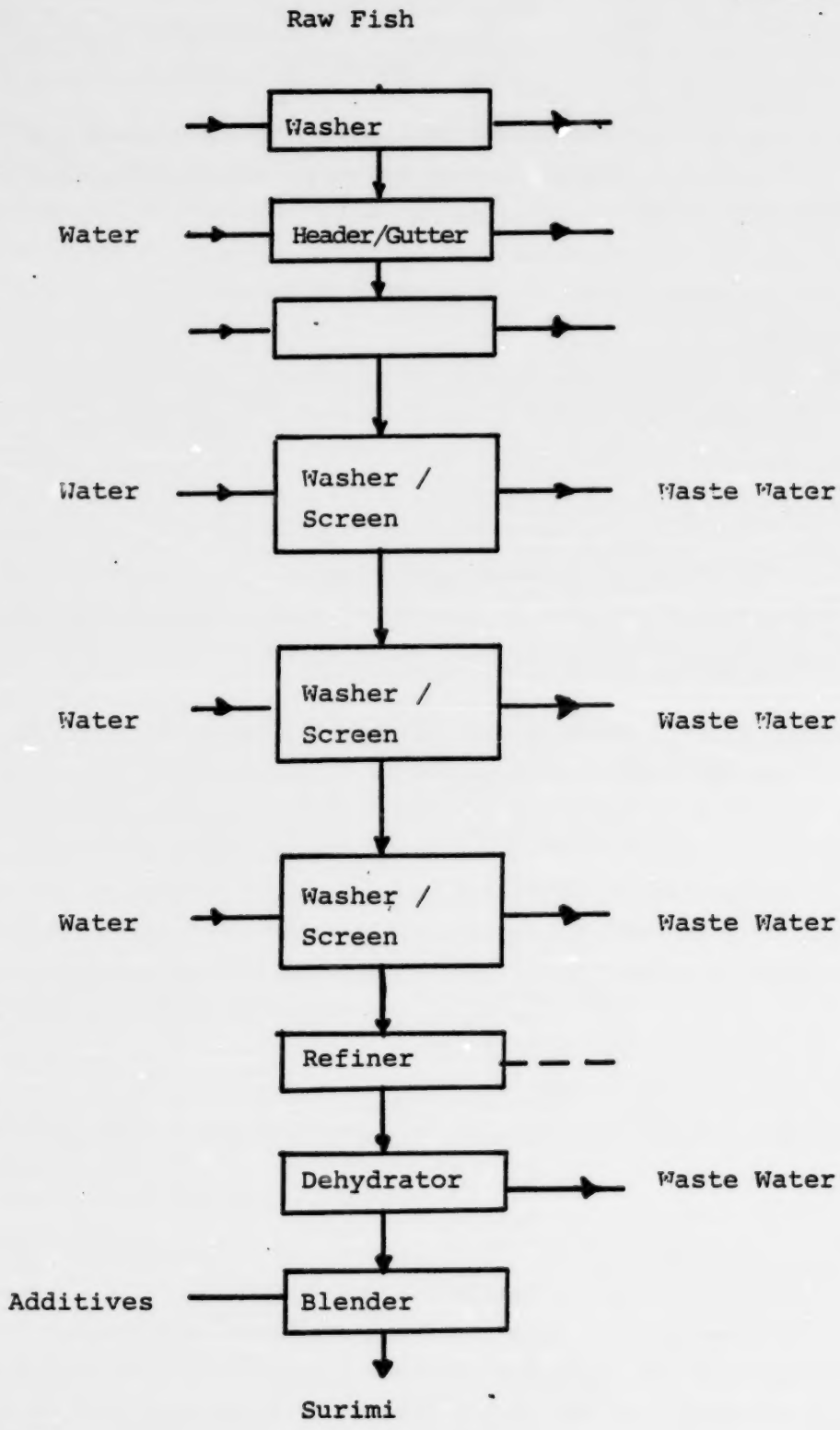
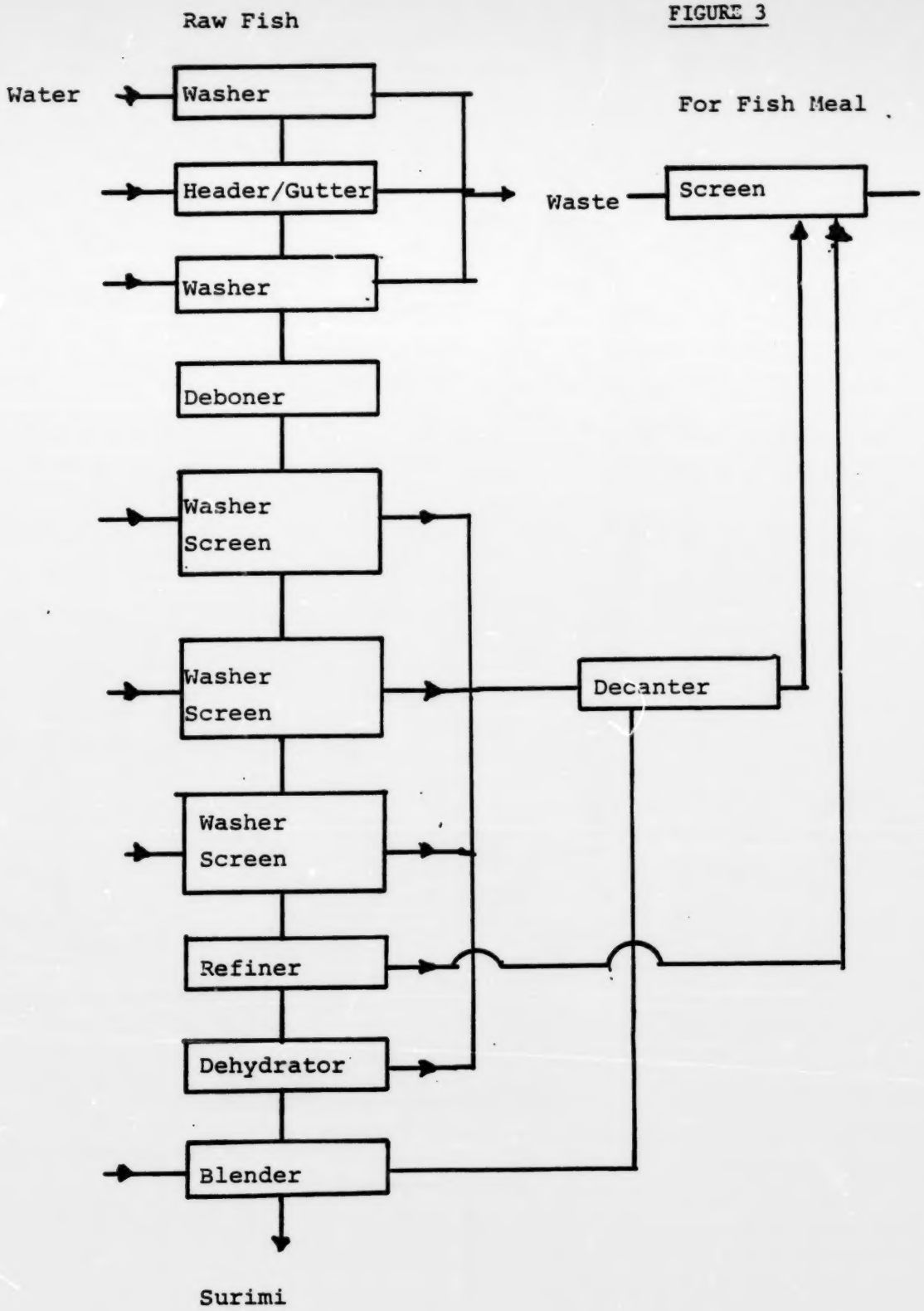

Raw Fish
Washer
Water
Header/Gutter
Water
Washer / Screen
Waste Water
Water
Washer / Screen
Waste Water
Water
Washer / Screen
Waste Water
Refiner
Dehydrator
Waste Water
Additives
Blender
Surimi

FIGURE 2

Vessel
Solids discharge port
Main drive pulley
Inlet pipe
Solids outlet
Bowl
Conveyor
Base frame
Gravity disc
Effluent outlet
Gear box

FIGURE 3


Raw Fish
Water
Washer
Header/Gutter
Washer
Deboner
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Blender
Surimi
Waste
Screen
For Fish Meal
Decanter

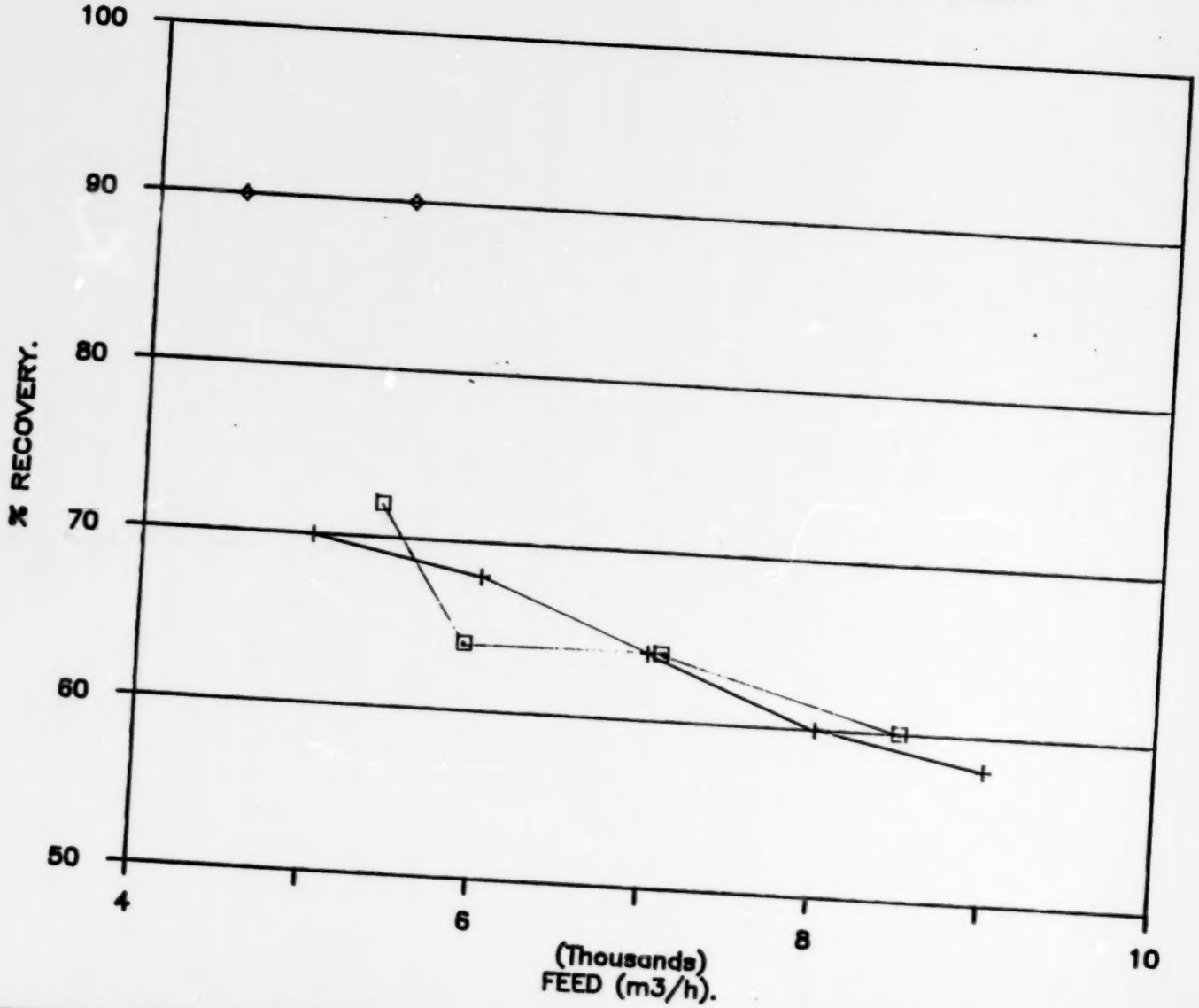

NON SOLUBLE DM. IN DECANTER.
100
90
80
70
60
50
% RECOVERY.
4
6
8
10
(Thousands)
FEED (m3/h).

FIGURE 4

FIGURE 5

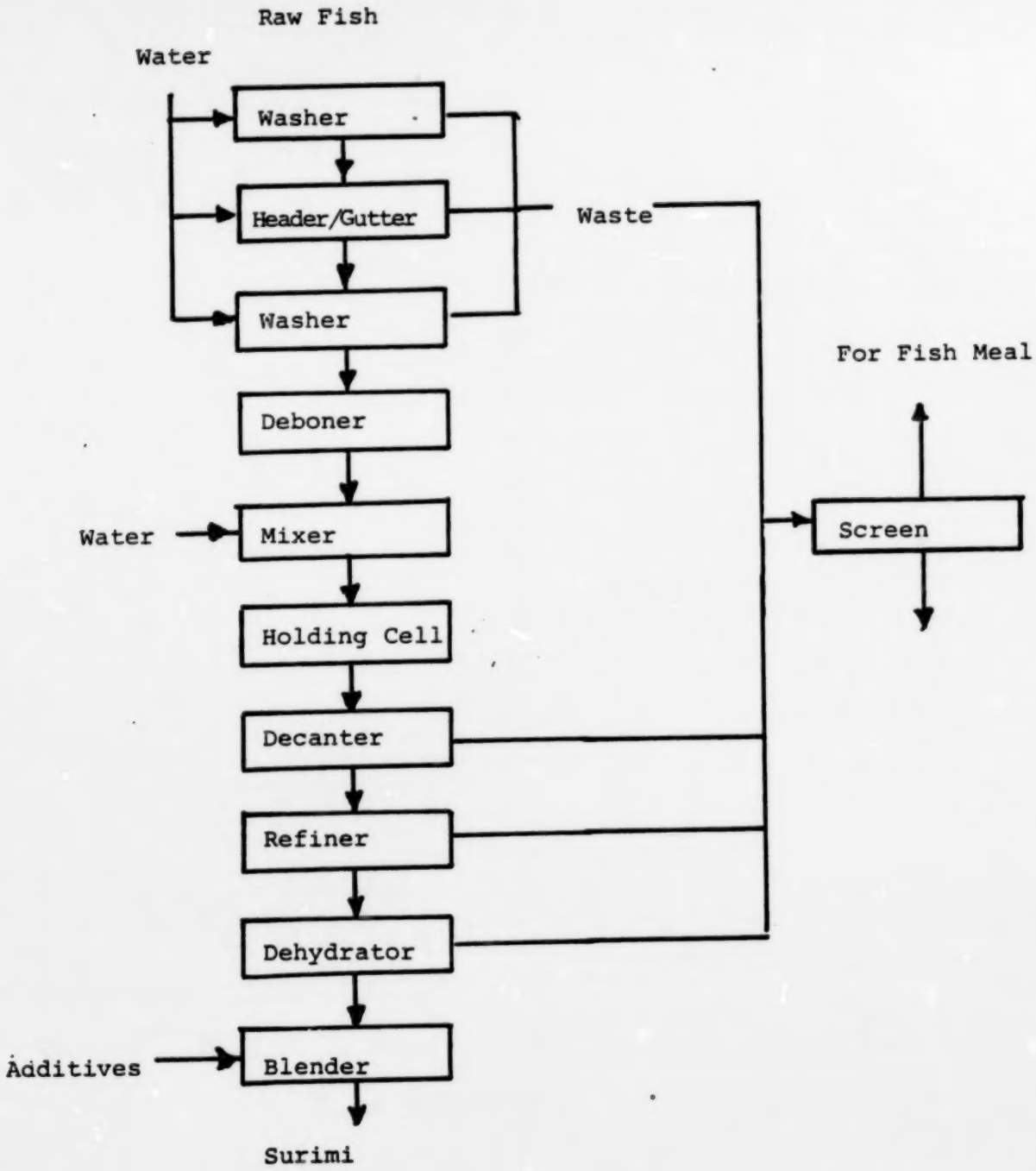
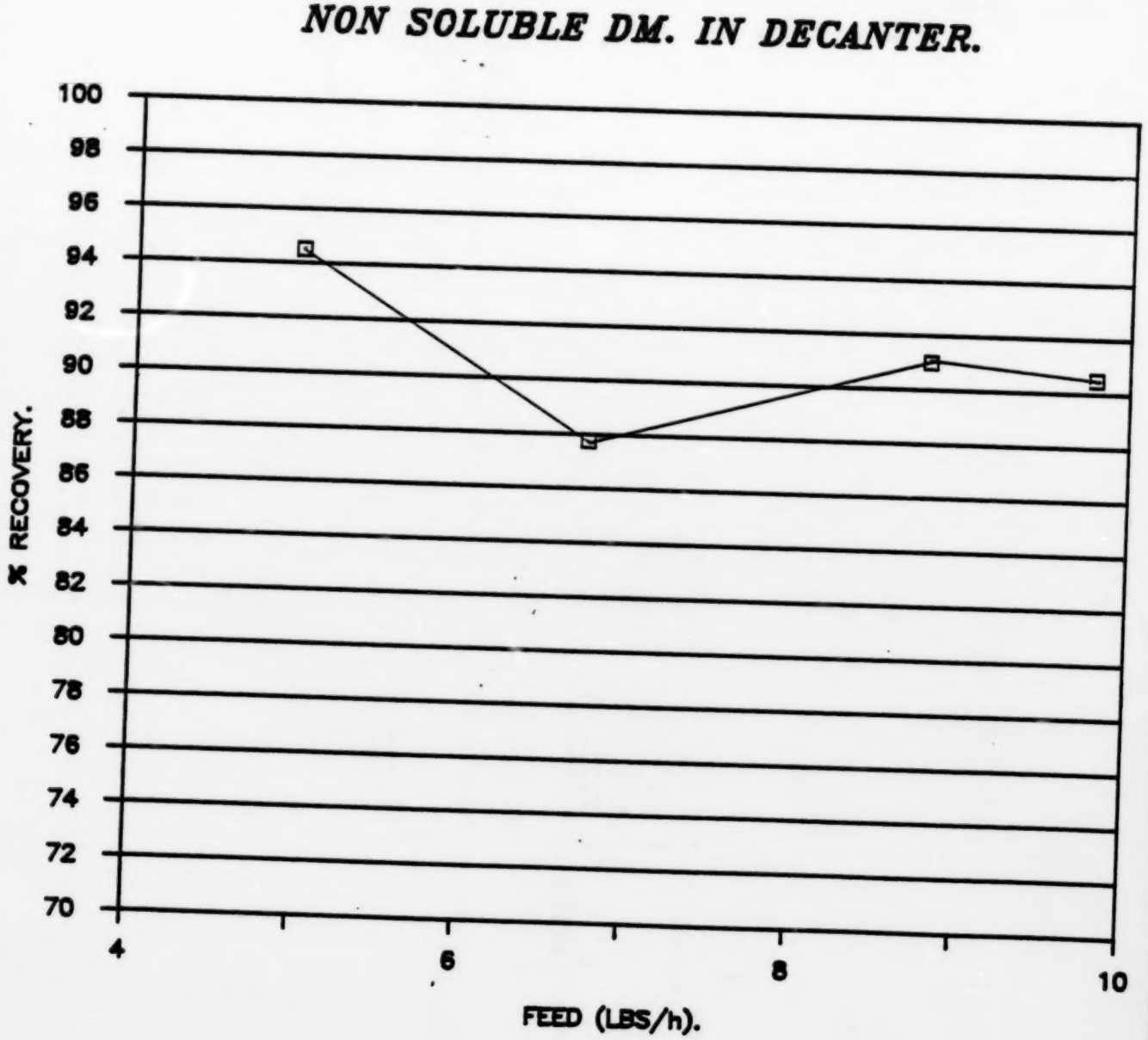

Raw Fish
Water
Washer
Header/Gutter
Waste
Washer
For Fish Meal
Deboner
Water
Mixer
Screen
Holding Cell
Decanter
Refiner
Dehydrator
Additives
Blender
Surimi

FIGURE 6


NON SOLUBLE DM. IN DECANTER.
100
98
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% RECOVERY.
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FEED (LBS/h).

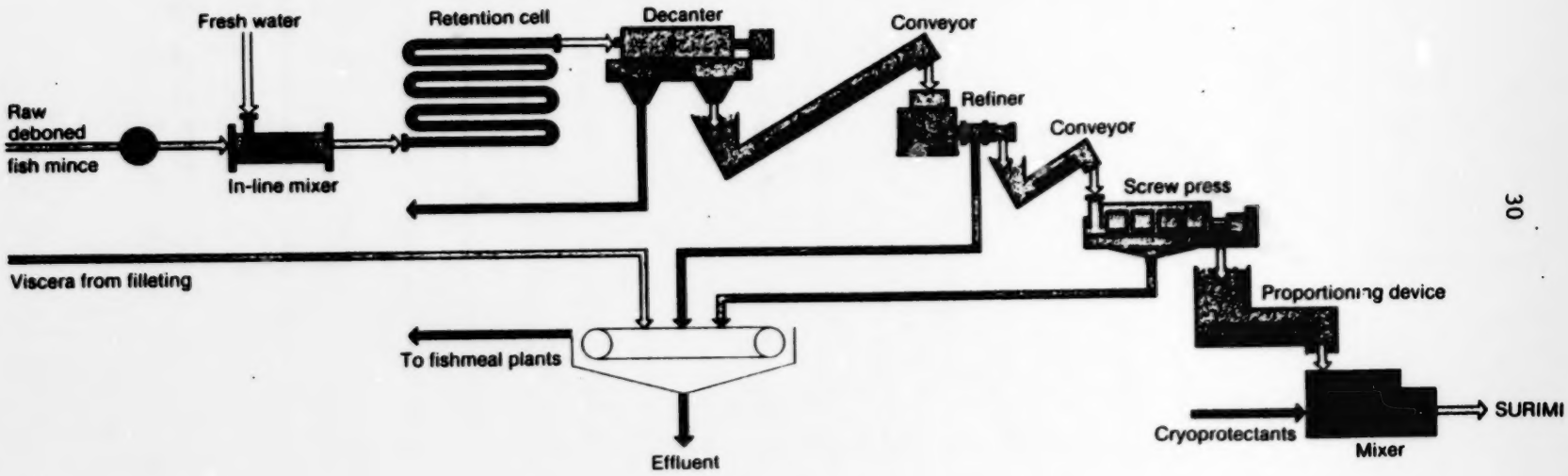
Fresh water
Retention cell
Decanter
Conveyor
Raw
deboned
fish mince
In-line mixer
Refiner
Conveyor
Screw press
Viscera from filleting
Proportioning device
To fishmeal plants
Effluent
Cryoprotectants
Mixer
SURIMI

FIGURE 7

TABLE 1

Effect of washing on the composition of minced pollock flesh

	Composition (%)			
	Moisture	Protein	Lipid	Ash
Conventional washing				
Mince	82.88	16.20	0.60	1.06
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1st wash	89.46	10.69	0.40	0.34
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3rd wash	92.78	7.30	0.30	0.13
Refined solids	92.88	6.94	0.26	0.14
Dewatered solids	86.59	13.49	0.40	0.07
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Refined solids	91.19	9.17	0.24	0.14
Dewatered solids	83.04	17.19	0.30	0.24

1ST QUESTION PERIOD

Several points were raised by participants which required clarification and/or elaboration by the presenters:

- The Alfa Laval System
  - recycled water/production costs
  - operating history of the system
  - the effect of decanting on quality
- Oily Species as Raw Material
- Distribution Channels
- Cost of Raw Material (Pollock)

1. Recycled Water/Production Cost: It was made clear that the existing model of the Alfa Laval system removes only suspended solids from water used in production. Re-use or recycling of water would require additional equipment, the price of which would offset any production cost advantage resulting from the recycling itself.

   At this time the system has only been proven in laboratory and trial operation; it has not been tested under commercial conditions. However, one plant has recently been marketed for onboard use later this year on a vessel in the North Sea.

   Initially, it was observed that shearing by the centrifugal decanter breaks the raw material into smaller pieces than conventional systems, but this has had no noticeable impact on end-product quality.

2. Oily Species as Surimi Raw Material: To date, production using the Alfa Laval system has involved mostly pollock - a lean species. Oily or fatty species have not been extensively tested.

It was noted, however, that the system's decanter results in comparable quality and colour to that produced by more conventional systems even at high speeds.

3. Distribution Channels: Quantities of surimi produced in the U.S. are expected to double (15 million pounds currently to 30 million pounds) next year. The marketing pattern which has emerged sees companies normally entering the food service sector initially. Once having established themselves there, they diversify into the retail sector. Each now accounts for about 50% of total volume.

4. Cost of Raw Material (Pollock): Pollock currently costs in the 8 cents per pound range in the U.S. and is predicted to reach 9 cents per pound in the near future. This is a concern because 10 cents per pound is considered to be the limit at which on-shore production remains feasible. A price above this range would necessitate a search for alternate raw material.

The Availability of Raw Material for Surimi Processing in Atlantic Canada

by

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Introduction

The purpose of this paper is to identify the various sources of raw material available for surimi processing in Atlantic Canada. It will cover the spectrum from fish resources that are now unutilized to resources that are very much utilized--but still not to the full extent possible. The paper will also discuss the level of accessibility of these resources and the constraints to access. In addition, some mention will be made of the ways and means of achieving access to the raw material. Some of the sources identified have competing uses. For others, access will be expensive, unless there are technological improvements to ease such access.

There are four main categories of resources to be addressed:

1. **Unutilized Species**--species and/or stocks that are not fished to any extent by either foreign or Canadian fleets. They are mostly by-catches, if taken at all. In general, less than 10% of the estimated available resource is harvested.
2. **Underutilized Species**--species and/or stocks that have directed fisheries by either Canadian or foreign fleets, but less than 50% of the estimated available resource is harvested.
3. **Foreign Utilized Species**--these are species and/or stocks that are fished by foreign countries

although there may be some involvement by the Canadian fleet. Many of these species are considered "surplus" to Canadian needs and, hence, under the Law of the Sea, Canada provides allocations of surplus stocks to nations with which it has bilateral fisheries agreements.

4. **By-Products of Existing Catches** - Fish frames from the groundfish fishery which are currently utilized only in minced products or as offal for fish meal.

Access to the Resource

Access to some species and stocks discussed in this paper is difficult, due to existing arrangements.

For example, all redfish and turbot stocks are allocated either to Canadian companies under the Enterprise Allocation Program, or to foreign nations because of the Law of the Sea requirements, or long-term agreements which Canada has with certain other countries.

Stocks allocated under the Enterprise Allocation Program are not available because, at the time the program started, it was agreed that the process would be for a trial period ending in 1988. Thus, even if the allocations are not utilized, they are not now available to others who might wish to use them.

However, there are ongoing discussions as to what should happen to such allocations. Currently, two options have been put forward:

1. to allow the current holder of the E.A. to enter into a contract with another party to harvest the resource; or
2. to have unutilized E.A.'s revert back to government for redistribution.

To date, no action has been taken.

For stocks which are fished by foreign nations, a somewhat similar situation applies. As a coastal state under the Law of the Sea Convention, Canada is obliged to identify "surplus" stocks and consider subsequent allocations to foreign countries, after establishing its own harvesting capabilities. Under the Law of the Sea, where Canada does not have the capacity to harvest the entire TAC, it must allow access to the surplus. This means that in order for Canada to increase its share, it must first demonstrate it has the capacity to harvest the resource. At present, this generally means the use of Canadian owned vessels. However, the policy on joint ventures is being refined, and joint Canadian-foreign harvesting operations may become more common. Still, there is no doubt that the greater the Canadian content in any proposal, the more favourably it is likely to be looked at by the Canadian government.

Some fish stocks are harvested by foreign nations under bilateral treaty obligations such as the Long Term Agreement with the EEC. Stocks covered under such agreements are not available to Canadians until the expiry of the agreement.

Generally speaking, only existing harvesting operations have access to resources at present. Any new proposals will require entrants to obtain licences for fishing operations, even if the proposal is to fish unutilized and unregulated resources.

Potential Raw Material Sources:

A: Unutilized Species

1) Argentine

Argentine is a groundfish around 40 cm. long and resembling a large smelt. It is most abundant on the edge of the Scotian Shelf and in the Fundian Channel, and occasionally occurs on the eastern slope of Georges Bank. There is a small fishery conducted by the U.S.S.R. and Japan using large offshore trawlers equipped with small mesh gear. This year (1987), the Total Allowable Catch (TAC) is 10,000 t, of which three quarters is foreign allocated. However, the catch in recent years has never exceeded 1,000 t, so the stock is virtually unutilized.

Resource Prospects:

Catches of argentine have been sporadic, ranging from 49,000 t in 1966 to less than 500 t recently. However, the catch is dependent on whether the U.S.S.R. and Japan conduct directed fisheries. Most recent estimates of sustainable yield for the 4VWX stocks is 10,000 t and this is expected to remain constant in the foreseeable future.

Recent Catch History:

	1981		1982		1983		1984		1985	
	TAC	CATCH	TAC	CATCH	TAC	CATCH	TAC	CATCH	TAC	CATCH
	(,000 t)		(,000 t)		(,000 t)		(,000 t)		(,000 t)	
Argentine - 4VWX										
- Canada	1.0	-	-	-	-	-	-	-	2.5	-
- Foreign	19.0	0.4	20.0	0.4	10.0	0.8	10.0	0.6	7.5	0.3
TOTAL	20.0	0.4	20.0	0.4	10.0	0.8	10.0	0.6	10.0	0.3

Constraints to Use:

Argentine has a short on-board storage life and there appears to be a need for special handling at sea. However, the extent of the problem is not fully understood and further research is necessary.

2) Arctic cod

The Arctic cod, which averages about 25 cm. in length, is a small relative of the Atlantic cod. It is found from the Arctic to the Grand Banks, but is mainly a northern fish. It is an important part of the Arctic food chain. The resource is now unutilized, but in the past, Arctic cod were often caught in small mesh gear as a by-catch of the U.S.S.R. offshore capelin fishery.

Resource Prospects:

No information is available on Arctic cod in the far north. But very large concentrations have been observed off northern Newfoundland and Labrador. Several hundred thousand tonnes may have been present in

2+3K in 1978, but abundance typically fluctuates widely. No reliable estimates of possible catches are available.

Recent Catch History:

Nil

Constraints to Use:

The importance of Arctic cod in the food chain would have to be examined. Also, the small mesh gear required to catch this species will catch juvenile forms of important commercial species. Arctic cod is highly variable and unpredictable in its availability, and it may not be possible to establish a stable fishery. Furthermore, due to the northerly distribution, ice conditions would dictate that vessels be ice-reinforced and have powerful engines in order to exploit the resource.

3) Sand Lance

This pelagic species may be one of the major unutilized species in the northwest Atlantic. Historically there have been large catches by fishing vessels from the Grand Banks to Georges Bank. Scientific information available on this species is limited. The fish ranges from approximately 20 to 35 cm. in length and, like capelin, is a major prey species for some of the traditional commercial fishes.

There is now no fishery for sand lance within Canadian waters, but in the north Sea, the Europeans land several hundred thousand tonnes annually.

Resource Prospects:

The biomass of sand lance is not well known. The estimated harvestable biomass on the Southern Grand Banks is 250,000 t, and another 100,000 t on St. Pierre Bank. Annual removals of 75-100,000 t may be possible. The biomass in other areas of Atlantic Canada is not known.

Recent Catch History:

Nil

Constraints to Use:

Environmental: Limited information on the distribution and behaviour of this species will be a constraint in any attempt to develop a fishery. More research is needed to determine the importance of sand lance as a forage fish and a cautious approach to developing a fishery for this species is likely.

Technological: There have been limited attempts to fish sand lance in Canadian waters. Success was achieved using a Danish (Butterfly) net but the catches varied considerably. The high incidental catch of traditional species is a problem, as well as the capture of immature fish in the small mesh gear.

4) Dogfish

Dogfish is viewed as one of the largest unutilized fish resources in the Northwest Atlantic. It is still considered a nuisance fish by fishermen as it damages their fishing gear as well as their catches.

These fish follow a yearly migratory pattern from Northern Carolina to Labrador. Since the 1970s, dogfish has been fished by several different European countries, particularly off the east coast of the U.S. in NAFO sub-areas 5 and 6.

In Canadian waters, the fishery is relatively small, consisting mainly of incidental or experimental catches.

Resource Prospects:

Dogfish is slow growing, long living, and late maturing. It therefore, has a low reproductive potential. The total estimated biomass in the Northwest Atlantic is 1,000,000 tonnes. An annual fishery of up to 500,000 t per year has been suggested. However, initiating a rational management plan for dogfish would probably result in a lower TAC because of the slow-growing, late maturing nature of the species.

Recent Catch History:

	1981		1982		1983		1984		1985	
	TAC	CATCH	TAC	CATCH	TAC	CATCH	TAC	CATCH	TAC	CATCH
	(,000 t)		(,000 t)		(,000 t)		(,000 t)		(,000 t)	
Dogfish										
- Canada	-	0.6	-	0.4	-	-	-	*	-	*
- Foreign	-	0.2	-	*	-	*	-	0.1	-	0.3
TOTAL	-	0.8	-	0.4	-	*	-	0.1	-	0.3

* less than 0.1

Constraints to Use:

Technological: There are few technological problems related to the capture and handling of dogfish, other than the requirement that they be handled and processed quickly because they excrete urea through the skin. In addition, they must be bobtailed on board. Processing of this species is labour intensive because the fish must be skinned by hand, as acceptable automated means have not been developed.

In 1985, the Department of Fisheries and Oceans, in conjunction with the Nova Scotia Department of Fisheries, carried out an experimental fishery for dogfish. In seventeen days, 4,000 kg of dogfish were landed along with 12,000 kg of catfish. Due to the short duration of the experiment, the low dogfish landings and high catfish by-catch, the effectiveness of the fishing technology could not be thoroughly analyzed. Thus, the results of the experiment were inconclusive.

B. Underutilized Species

Underutilized stocks are defined here to mean any stocks which have directed fisheries by either Canadian or foreign fleets, with less than 50% of the estimated available resource being harvested.

1) Redfish

Redfish (also known as ocean perch) is now regarded as an important commercial species. It is a deep-water species found at the edge of the fishing banks and in deep channels. On average, less than half of

the approximately 200,000 t TAC of redfish has been harvested in recent years.

Obviously, redfish is one of those species for which there are competing uses. The species is underutilized (or foreign utilized) because Canadians have not been able to expand their markets. Considering the large portion of the TAC which is either uncaught, or is foreign caught, redfish offers considerable potential as a source of raw material for surimi processing.

Resource Prospects:

For the redfish stock currently underutilized, TACs are expected to remain unchanged over the next few years.

Recent Catch History:

	1981		1982		1983		1984		1985	
	TAC	CATCH	TAC	CATCH	TAC	CATCH	TAC	CATCH	TAC	CATCH
	(,000 t)		(,000 t)		(,000 t)		(,000 t)		(,000 t)	
REDFISH 3LN										
- Canada	8.0	7.9	10.0	7.3	12.0	6.2	12.9	1.3	10.7	2.4
- Foreign	17.0	16.0	15.0	14.3	13.0	13.3	12.1	13.4	14.3	18.9
TOTAL	25.0	23.9	25.0	21.6	25.0	19.5	25.0	14.7	25.0	21.3
REDFISH 3O										
- Canada	7.5	2.6	7.5	0.5	7.5	*	7.5	0.2	7.5	0.1
- Foreign	12.5	10.0	12.5	10.9	12.5	7.1	12.5	9.8	12.5	7.2
TOTAL	20.0	12.6	20.0	11.4	20.0	7.1	20.0	10.0	20.0	7.3

* Less than 0.1

REDFISH 3P										
- Canada	16.0	9.1	16.0	5.8	16.0	5.9	16.0	4.6	16.0	3.5
- Foreign	2.0	*	2.0	-	2.0	-	2.0	-	2.0	-
TOTAL	18.0	9.1	18.0	5.8	18.0	5.9	18.0	4.6	18.0	3.5
REDFISH 4VWX										
- Canada	18.5	17.7	25.0	13.6	27.0	12.1	28.0	8.0	28.0	12.9
- Foreign	11.5	*	5.0	*	3.0	0.1	2.0	1.4	2.0	1.2
TOTAL	30.0	17.7	30.0	13.6	30.0	12.2	30.0	9.4	30.0	14.1

* Less Than 0.1

Constraints to Use:

Environmental: Redfish 30, and 4VWX: For the 30 stock, small fish and low catch rates are problems--the larger fish are in deeper water on bottom difficult for trawlers to fish. The 4VWX stock has suffered from parasite infestations.

Technological: Redfish 3LN and 30: Harvesting of these stocks requires powerful vessels due to the water depths in which the stocks occur. Most Canadian trawlers are under-powered for these depths. The general indication seems to be that 2000 BHP is the minimum engine size required. However, this is disputed.

Other: The fact that redfish is now a commercially valuable species creates some problems for its use in surimi processing. Marketing has probably been the biggest constraint to fuller utilization of the resource. If the marketing issue can be successfully addressed, there is no doubt that redfish potentially available for surimi use will decrease considerably.

2) Turbot

Like redfish, turbot is a commercially important species which is currently underutilized for a number of reasons. Turbot, also known as Greenland halibut, is a deepwater flatfish. It is most abundant from the Davis Strait to the north slope of the Grand Banks. There are four recognized stocks of turbot - the Davis Strait stock, the northern Labrador stock, the Labrador-Northern Grand Banks stock, the Gulf of St. Lawrence stock. The total TAC within Canada's zone in 1987 is 120,000 t, of which almost one-third is foreign allocated. The Canadian catch in recent years has averaged around 28% of Canada's quotas.

Resource Prospects:

The TACs for all turbot stocks are expected to remain at present levels for the foreseeable future. In 1987, the TACs for the Labrador and Northern Grand Banks stocks have increased to 100,000 t and are expected to remain there until at least 1991.

Recent Catch History:

	1981		1982		1983		1984		1985	
	TAC	CATCH	TAC	CATCH	TAC	CATCH	TAC	CATCH	TAC	CATCH
	(,000 t)		(,000 t)		(,000 t)		(,000 t)		(,000 t)	
TURBOT 0										
- Canada	5.0	-	3.0	-	3.0	-	3.0	-	3.0	-
- Foreign	7.5	0.1	9.5	1.6	9.5	1.7	9.5	0.6	9.5	1.3
TOTAL	12.5	0.1	12.5	1.6	12.5	1.7	12.5	0.6	12.5	1.3
TURBOT 2GH										
- Canada	-	*	-	3.3	15.0	2.6	15.0	1.9	15.0	1.8
- Foreign	-	3.9	-	0.1	5.0	2.3	5.0	2.5	5.0	0.6
TOTAL	-	3.9	-	3.4	20.0	4.9	20.0	4.4	20.0	2.4

* Less than 0.1

TURBOT 2J3KL										
- Canada	48.5	23.6	48.5	17.4	48.5	16.4	48.5	17.9	48.5	12.9
- Foreign	6.5	2.2	6.5	4.6	6.5	5.7	6.5	1.8	6.5	2.1
TOTAL	55.0	25.8	55.0	22.0	55.0	22.1	55.0	19.7	55.0	15.0

Constraints to Use:

Technological: Again, as with other species, these turbot stocks concentrate in deep water. Acquiring vessels which can trawl at such depths may make the harvesting of such stocks economically unattractive. However, the East Germans have had some success trawling these stocks and the Portuguese have recently demonstrated that deepwater gillnetting can be successful.

Other: Turbot, like redfish, is a commercially valuable species at present, and this competing use may decrease its availability for surimi processing, especially if markets for traditional uses expand.

3) Capelin

The capelin is a commercially important pelagic species, particularly in Newfoundland. It is also a major forage fish for many commercially important groundfish. Traditionally 25,000 t to 50,000 t of capelin are taken as bait, human food, dog food and fertilizer. Catches have increased over the past four years as exports of roe-bearing females to Japan continue to grow. Because only roe-bearing females are marketed, the resource is considered underutilized.

Capelin is fished commercially mainly by the inshore harvesting sector

and this fishery takes place in the early summer. However, an offshore fishery has been conducted in the past.

Resource Prospects:

The substantial fluctuations in recruitment as well as the complexity of relationships with predator species make yield predictions difficult and large variations in the TACs result. At the present time, because of these factors, resource prospects over the coming years are not available. However, it is believed that there will be, on average, close to 200,000 t available, through to the early 1990s, for all stock areas which include NAFO Divisions 2+3K, 3LNOPs, and 4RST.

Recent Catch History:

	1981		1982		1983		1984		1985	
	TAC	CATCH	TAC	CATCH	TAC	CATCH	TAC	CATCH	TAC	CATCH
	(,000 t)		(,000 t)		(,000 t)		(,000 t)		(,000 t)	
CAPELIN-2+3K										
- Canada	0	1.8	3.0	3.8	40.0	4.1	38.2	8.1	38.2	8.4
- Foreign	10.0	10.1	10.0	9.7	10.0	9.9	16.8	16.9	16.8	16.6
TOTAL	10.0	11.9	13.0	13.5	50.0	14.0	55.0	25.0	55.0	25.0
CAPELIN-3L										
- Canada	30.0	24.5	30.0	28.3	60.0	25.0	38.0	33.4	60.0	25.7
- Foreign	-	-	-	-	-	-	-	-	-	-
TOTAL	30.0	24.5	30.0	28.3	60.0	25.0	38.0	33.4	60.0	25.7
CAPELIN-3Ps										
- Canada	-	0.2	-	*	-	0.2	-	1.2	-	0.1
- Foreign	-	-	-	-	-	-	-	-	-	-
TOTAL	-	0.2	-	*	-	0.2	-	1.2	-	0.1
CAPELIN-4RST										
- Canada	30.0	2.4	30.0	0.4	30.0	1.0	30.0	1.2	30.0	2.4
- Foreign	-	-	-	-	-	-	-	-	-	-
TOTAL	30.0	2.4	30.0	0.4	30.0	1.0	30.0	1.2	30.0	2.4

* Less than 0.1

Constraints to Use:

The inshore fishery is highly seasonal, and the economics of an offshore fishery are uncertain.

4) Atlantic Mackerel

Atlantic mackerel in the northwest Atlantic consists of two populations, southern and northern. Most of the Canadian catch is taken from the northern stock, and is fished during the migration towards the Gulf of St. Lawrence spawning grounds.

Most major world stocks of mackerel are underutilized, as market prospects are now much lower than the available resource. The low price for mackerel on the world market has prevented the development of a Canadian mackerel industry.

To date, the Canadian mackerel fishery has been solely inshore, although there have been recent attempts to establish a large seiner fishery. More effective technologies to capture larger volumes of mackerel at low cost would enhance its utilization.

Resource Prospects:

The scientific advice on mackerel suggests potential yearly harvests in the order of 150,000 t without endangering the stocks. This, of course, would include landings in U.S. waters, as mackerel migrate towards the Scotian Shelf and Gulf of St. Lawrence.

Until recently, stock assessment work on mackerel has been somewhat limited and increased research in this area is needed.

Recent Catch History:

MACKEREL	1981 TAC	1981 CATCH (,000 t)	1982 TAC	1982 CATCH (,000 t)	1983 TAC	1983 CATCH (,000 t)	1984 TAC	1984 CATCH (,000 t)	1985 TAC	1985 CATCH (,000 t)
- Canada	-	19.3	-	16.4	-	19.3	-	16.0	-	26.0
- Foreign	-	*	-	*	-	*	-	0.7	-	1.0
TOTAL	-	19.3	-	16.4	-	19.3	-	16.7	-	27.0

* Less than 0.1

Constraints to Use:

Environmental: Yearly predictions of fish abundance in specific inshore areas of the Atlantic are difficult. Because of mackerel's tendency to migrate very quickly from one bay to another, the inshore fishery, being somewhat passive in nature, cannot follow it. As a consequence, continuing supply is a problem. Migration to northern (especially Newfoundland) waters is thought to be heavily influenced by hydrographic conditions, as well as total stock size.

Technological: Several constraints in mackerel utilization are attributable to technology. The most serious is the high perishability of the fish. Special handling and treatment is required by the inshore fleet and onboard processing/freezing capacity by the offshore. For the latter, policy has not been expressed regarding processing mackerel at sea. There is no evidence that an offshore fishery is feasible within the Canadian 200-mile zone. (There have been attempts in the U.S.) There is also no certainty of the capability of large seiners to fish for

mackerel using purse seines. Experiments on the Scotia Shelf and in the Gulf in 1984-85 were inconclusive.

C. Foreign Utilized Species

1) Roundnose grenadier

Grenadier, or rattail, are worldwide in distribution, living near the bottom from the Arctic to the Antarctic. The roundnose grenadier, which is almost 35 cm. long, is considered to be present in significant commercial quantities off the east coast. However, the species is unutilized by Canada, and the fishery is entirely foreign—largely conducted by the U.S.S.R. Two stocks have been identified for management purposes: The Davis Strait (NAFO Division 0B) stock and the Labrador-Grand Banks (2+3) stock. The total TAC has been 15,000 t for the past several years—14,000 t of which has been foreign allocated. Although there are few or no landings in Area 0, landings have been stable at about 4,000 t or 38% of foreign allocations in 2+3.

Resource Prospects:

The data available for grenadier are very limited. The low catches in recent years may be, in part, due to limitations in the permitted by-catch of Greenland halibut. Catch rates have declined since the mid-1970s and TACs have been reduced accordingly. The present TAC levels will likely remain stable in the foreseeable future.

Recent Catch History:

	1981		1982		1983		1984		1985	
	TAC	CATCH	TAC	CATCH	TAC	CATCH	TAC	CATCH	TAC	CATCH
	(,000 t)		(,000 t)		(,000 t)		(,000 t)		(,000 t)	
ROUNDNOSE GRENADIER - 0										
- Canada	0.5	-	0.5	-	0.5	-	0.5	-	0.5	-
- Foreign	3.5	-	3.5	*	3.5	*	3.5	*	3.5	*
TOTAL	4.0	-	4.0	*	4.0	*	4.0	*	4.0	*
ROUNDNOSE GRENADIER-2+3										
- Canada	0.5	-	0.5	-	0.5	-	0.5	-	0.5	-
- Foreign	26.5	6.8	26.5	3.9	10.5	3.4	10.5	3.9	10.5	4.8
TOTAL	27.0	6.8	27.0	3.9	11.0	3.4	11.0	3.9	11.0	4.8

* Less than 0.1

Constraints to Use:

Environmental - Both Stocks: The Davis Strait stock and the northern part of the 2+3 stock are in areas where ice conditions inhibit the fishery. Canadian trawlers would need ice-reinforced hulls and more powerful engines to fish these stocks. However, it is possible to fish grenadier in the summer and fall when ice is not a problem.

Technological - Both Stocks: Most Canadian vessels are underpowered for fishing at the depths were grenadier concentrate.

2) Silver hake

Silver hake, a member of the cod family about 60 cm. long, is found from Newfoundland to North Carolina, but main concentrations are on the

Scotian Shelf and Georges Bank. Most dense concentrations of silver hake are associated with spawning, when the fish move into very shallow water, which in Canada occurs in the Sable Island Bank area. The fish are harvested mainly by small-meshed bottom trawls which may generate a by-catch of young fish of other commercial species. The U.S.S.R. and Cuba are the chief users of the species, although the U.S. also has some history in utilization of the species off its coast. In 1987, the TAC in the Canadian zone is 100,000 t, 70,000 of which is foreign allocated. The Canadian quota includes 10,000 t for an experimental fishery surimi project. In recent years, the total catch has averaged almost two-thirds of the TAC.

Resource Prospects:

Through the 1970s, the silver hake resource on the Scotian Shelf (4VWX) experienced pronounced fluctuations in recruitment. Difficulty in predicting recruitment limits the usefulness of resource projections to more than one year for this species. However, it is assumed that a TAC of 70,000-100,000 t will be sustainable through 1990.

Recent Catch History:

	1981		1982		1983		1984		1985	
	TAC	CATCH	TAC	CATCH	TAC	CATCH	TAC	CATCH	TAC	CATCH
	(,000 t)		(,000 t)		(,000 t)		(,000 t)		(,000 t)	
SILVER HAKE - 4VWX										
- Canada	20.0	-	1.0	*	1.0	-	1.0	-	1.0	-
Foreign	60.0	38.3	79.0	58.1	79.0	34.2	99.0	73.2	99.0	76.0
TOTAL	80.0	38.3	80.0	58.1	80.0	34.2	100.0	73.2	100.0	76.0

* Less than 0.1

Constraints to Use:

Technological: This species is highly perishable and requires on-board freezing/processing capability for offshore vessels. The Canadian FFT fleet currently consists of one ship, although there are some vessels with freezing-only capability. This fishery requires small mesh gear and is, therefore, subject to restrictions. Because of the use of small mesh gear, care has to be taken to avoid by-catches of juvenile forms of important groundfish species.

SUMMARY OF SPECIES/STOCKS WHICH ARE POTENTIALLY AVAILABLE FOR THE SURIMI INDUSTRY

	Stock (NAFO Divisions)	1987 TAC (t)	Estimated Annual TAC Long-Term (t)	Potential For Development
Unutilized:				
Argentine	4VWX	10,000	10,000-20,000	Medium
Arctic Cod	0, 2+3	n.a.	n.a.	Low
Sand Lance	3, 4, 5	n.a.	100,000	Medium
Dogfish	3, 4, 5	n.a.	200,000 (?)	Medium
Underutilized				
Redfish	30	20,000	20,000	
	3P	18,000	18,000	High*
	4VWX	30,000	30,000	
Turbot	0	12,500	12,500	
	2GH	35,000	35,000	High*
	2J3KL	65,000	65,000	
Capelin	2+3K	55,000		
	3LNOPs	60,000	200,000	High
	4RST	30,000		
Mackerel	3, 4, 5	n.a.	150,000	Medium
Foreign Utilized				
Redfish	3LN	25,000	25,000	High*
Roundnose Grenadier	0	4,000	4,000	
	2 + 3	11,000	11,000	Low
Silver Hake	4VWX	100,000	100,000	High
TOTAL	-	**475,500**	**990,500**	

* These resources have competing uses and may not be available for surimi.

OTHER SOURCES OF RAW MATERIAL FOR SURIMI PROCESSING

Fish Frames:

Undoubtedly, the largest potential source of raw material for surimi processing is the groundfish material that now goes into minced product and fish meal--the fish frames. Approximately 40% of head-on, gutted fish is the frame; that is, the portion left after the fillets have been removed. In turn, the yield from frames is about 25-30%.

In 1985, almost 763,000 t of groundfish were landed in Atlantic Canada. Based on standard conversion factors, this means about 250,000 t of fish frames were potentially available as a source of raw material for surimi processing. Of course, it is unlikely that this quantity would ever be converted, but the point is obvious: given this wealth of readily available material, the potential for development is very good.

The large quantity of groundfish now landed in Atlantic Canada means that there is a large volume of material available for which no harvesting costs are involved. The only costs are the opportunities which must be foregone in diverting the material from minced product and fish meal and transportation costs.

For large offshore plants, it may be possible to set up a surimi line adjacent to their existing operations. The quantity of frames from large plants may be sufficient to make such an investment economically viable.

However, a large portion of Atlantic Canada's groundfish goes through small plants, and a surimi operation would need to be supplied by several plants to generate the needed quantities. The problem of

access is much different from that of a large plant. First, it is necessary to negotiate a contract with several plants. Those plants will need modifications to intercept the fish frames before they go to offal. There are also transportation problems to be worked out. These include costs (first and foremost), as well as scheduling and other related difficulties.

Of course, there is also the problem of seasonality in many areas. Offshore fish is harvested year round. However, most of the smaller plants shut down for periods of the year. This creates a seasonality problem for the surimi processor. But, given the potential that exists for surimi from fish frames, no doubt any difficulties can be overcome with a little planning and a lot of effort.

ATLANTIC CANADA GROUNDFISH LANDINGS (PRELIMINARY)
(Quantity in Metric Tonnes, Round Weight)

GROUNDFISH LANDINGS	1985	1984
NEWFOUNDLAND		
- Cod	271,402	275,967
- Haddock	2,882	1,256
- Redfish	28,416	19,759
- Small Flatfishes	63,766	51,307
- Turbot	14,779	19,808
- Pollock	2,534	1,265
- Hake	848	623
- Other	2,535	2,020
TOTAL	387,162	372,005
NOVA SCOTIA		
- Cod	148,220	144,101
- Haddock	33,785	31,237
- Redfish	26,089	22,622
- Small Flatfishes	15,442	21,677
- Turbot	792	360
- Pollock	41,191	33,148
- Hake	10,233	8,125
- Other	9,315	9,218
TOTAL	285,067	270,488
PRINCE EDWARD ISLAND		
- Cod	5,831	5,748
- haddock	18	107
- Redfish	6,277	10,430
- Small Flatfishes	2,943	2,723
- Turbot	9	-
- Pollock	1	1
- Hake	1,717	3,197
- Other	8	12
TOTAL	16,804	22,218

Atlantic Canada Groundfish Landings
(Quantity in Metric Tonnes, Round Weight)

GROUNDFISH LANDINGS	1985	1984
NEW BRUNSWICK		
- Cod	12,589	12,082
- Haddock	132	82
- Redfish	2,844	2,343
- Small Flatfishes	2,512	1,749
- Turbot	140	69
- Pollock	792	448
- Hake	860	1,276
- Other	13	42
TOTAL	19,882	18,091
QUEBEC		
- Cod	38,466	37,573
- Haddock	22	10
- Redfish	9,260	13,855
- Small Flatfishes	3,376	2,655
- Turbot	1,963	1,510
- Pollock	-	-
- Hake	343	485
- Other	208	102
TOTAL	53,638	56,190
ATLANTIC CANADA - TOTAL		
- Cod	476,508	475,471
- Haddock	36,839	32,692
- Redfish	72,886	69,009
- Small Flatfishes	88,039	80,111
- Turbot	17,683	21,747
- Pollock	44,518	34,862
- Hake	14,001	13,706
- Other	12,079	11,394
TOTAL	762,553	738,992

Laboratory and Pilot Scale Production of Surimi From Selected Atlantic Canadian Fish Species

by

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Introduction

In 1985, a three-phase proposal was made to the Fisheries Development Branch, Department of Fisheries and Oceans to study the potential of selected Canadian Atlantic fish species and shellfish wastes to produce surimi and shellfish flavours. A contract was awarded to the Marine Institute (Food Technology Department) and Memorial University (Biochemistry Department) by the Fisheries Development Branch to carry out the study. The work commenced in September 1985. The Marine Institute was responsible for investigating the acceptability of raw material for surimi production, while Memorial University concentrated on the extraction of shellfish flavours for use in surimi-based shellfish analogues.

Over the past decade, there has been an increasing interest in surimi and surimi-based products. Surimi is a Japanese word for mechanically deboned fish flesh that has been washed in water and mixed with cryoprotectants. Due to its unique properties, it is very attractive to food processors and food technologists. Surimi has long-term frozen storability. Because of its bland flavour, versatility and malleability, it can be flavoured with natural and artificial additives to produce a variety of products, from seafoods to confectionery. Their low fat calorie content and high protein value make surimi-based products attractive to health conscious consumers.

Materials and Methods

Species investigated for their suitability in surimi production included trawler and trap cod, capelin, redfish, flounder and haddock. In this report, when a fish is termed "split" it means headless, gutted fish that have been cut ventrally to the dorsal edge, leaving the backbone intact. Unlike the "regular split," the soundbone has been removed, together with the anterior part of the backbone.

Laboratory Scale Surimi

Laboratory scale surimi was produced by deboning fillets in a deboner (Baader 694, drum size 3mm or 5mm bore) and washing them in cool tap water (2°C-7°C). The amount of water used for washing was twice the weight of the minced flesh. It was washed for ten minutes and the mixture decanted through a stainless steel china cap strainer (1mm bore). A total of three washings were carried out, each for a duration of ten minutes. The third and final washing was done in a 0.3 NaCl. The washed minced fish flesh was then put in a heavy grade, closely woven muslin bag and dewatered with a Carver press at 5,000 p.s.i. for five minutes. Cryoprotectants (i.e., 4% sorbitol, 4% sucrose and 0.3% sodium polyphosphate) were mixed with the dewatered flesh in a Hobart mixer for about three minutes. Thus surimi was produced.

Pilot Scale Surimi

The surimi pilot line was installed by the Bibun Company of Japan in February 1986 at the Marine Institute, St. John's, Newfoundland. The line consisted of the following:

1. the deboner or meat separator
2. the first leaching tank
3. the first rotary sieve
4. the second leaching tank
5. the second rotary sieve
6. the refiner, and
7. the dewatering screwpress.

Essentially, the pilot scale surimi produced from the Bibun Surimi Line followed a process similar to that described for laboratory scale surimi production except that the whole process was automatic and included only two washings (each of ten minutes duration). The second and final washing was carried out in 0.3% saline. Another difference was that the pilot line had a refiner which separated impurities (like bone, scales, dark meat, etc.) from the washed fish flesh. The resulting refined fish flesh was dewatered through a screw press. It was then mixed with cryoprotectants (i.e., 4% sucrose, 4% sorbitol, and 0.3% sodium polyphosphate) in a silent cutter for about three minutes to produce surimi.

Any variations to the above described methods of laboratory and pilot scale surimi production, if carried out, would be stated.

Surimi Analyses

Various standardized tests, as described by Chandra (1986), were conducted to ascertain the quality of surimi produced. The moisture content; pH; whiteness of surimi, as indicated by the "L" value of the Hunter-Gardner tristimulus colorimeter; foreign elements present; fold test score; shear stress (gel strength); and shear strain values of surimi produced were noted during the surimi analyses.

Results and Discussion

Trawler Cod

Some properties of surimi prepared from 28 lots of trawler cod are summarized in Tables 1 and 2. The quality of both laboratory and pilot-scale surimi produced from trawler cod compared favourably with surimi produced commercially from trap cod at the Terra Nova Fishery plant in Clarenville. Details of test results conducted on pilot and laboratory scale surimi are summarized in Appendix A, and Tables 1-12. Generally colour, gel strength and ductility of the surimi produced from trawler cod were as good as, if not better than, that of the commercially produced trap cod surimi. It must be stressed that, as only one sample from Terra Nova Fishery was available for testing, it can only be used as an indicator.

During production, it was observed that Grade 2 quality trawler cod with slight odour (usually after the post-mortem age of about 8 days), when processed into surimi, lost its odour and produced a reasonable quality product. This has great significance, as it may be a means of disposing of Grade 2 quality cod for which there is limited demand commercially.

For ten laboratory and eleven pilot trawler cod surimi samples, analysis indicated that gel strength (torsion shear stress) was not influenced by freshness of raw material, and most of the variation in gel strength could be explained on the basis of surimi moisture content. Ductility (torsion shear strain), however, was influenced by freshness of raw material and, to a lesser extent, by the moisture content of the surimi (Table 7).

In December 1986, surimi was produced successfully from frozen trawler cod on the pilot line. The product was white and gave a maximum score

of 5 on the fold test. The stress (gel strength) and especially the strain (ductility) values were remarkably good (Table 5 - process date December 16, 1986, 14.3 Kpa and 2.55 respectively for surimi cooked at 90°C). This ability to produce surimi from frozen cod opens up great possibilities, as cod could be frozen during the glut period and processed into surimi in the slower months of the year.

Trap Cod

Trap cod surimi was less white than that produced from trawler cod. This may partly be because trap cod was processed round and unbled, while trawler cod was gutted and bled. The mean (90°C) "L" values from the trap cod surimi prepared from fillets was 72.2, while the corresponding value for trawler cod surimi was 77.8 in the pilot scale studies. ("L" value 0 = black reference, 93.7 = white reference.) Some of the values for moisture content of trap cod surimi were quite low compared to figures obtained from trawler cod tested in the pilot scale studies. Better dehydration in the screw press may help explain this difference.

From the limited pilot scale studies conducted, the stress and strain values obtained from the trap cod fillet surimi were generally lower than obtained on the trawler cod fillet surimi.

Good quality surimi can be produced by trap cod with good gel strength and pliability.

Capelin

One of the main limitations of capelin studies is the brief period of availability of fresh capelin. The gutting and skinning of the male capelin is difficult because of its small size. A nobbing machine (Baader 461) was used to gut, and a squid skinning machine was adapted to help in the washing of the capelin after it had been gutted and sectioned.

Various experiments were carried out with previously frozen capelin as to how to best carry out the skinning process. The Norwegian process, as described by Eide et al (1982) was used. Sections of capelin in low pH were agitated rapidly in water between 40°C and 50°C. There were some skinning effects, but the results were not as positive as indicated by the research paper. Very little black membrane was removed.

Better skinning results were obtained by immersing the gutted, sectioned capelin in hot water (90°C to 95°C for 4 to 5 seconds) and then washing it in chilled 0.05% NaCl. Fairly good results were also obtained by immersing the gutted capelin in warm water (45°C) for about 3 minutes and subsequently running the capelin through a scaler. There is a fine balance between providing enough heat to skin the capelin easily and overheating which could affect the underlying flesh below the skin.

Surimi both on a laboratory and pilot scale was produced from male capelin. It was found that fair quality surimi can be produced. The results obtained were encouraging. They are summarized in Tables 9 and 10. Surimi produced from capelin differed from that from cod. It was less white. It had a grey to beige colour. This was to be expected as capelin flesh is not as white as cod. The average "L" value of raw capelin surimi (pilot scale) was around 39, while the corresponding

value for trap cod surimi was 53. Capelin surimi had a lower fold test value than trap cod or trawler cod surimi. There was also more foreign matter in capelin surimi.

Stress values were generally lower than for cod. The strain values which indicate pliability were comparable to that of cod surimi. There was a faint capelin odour detected on the capelin surimi produced.

Frozen Capelin Surimi

During this project, surimi, for the first time, was successfully produced from previously frozen capelin (Table 10). The gel strength (shear stress) values were comparable to that produced from fresh capelin. This fact makes it possible for greater exploitation of the underutilized male capelin, which is now mainly treated as fish meal or waste. During the short, extremely busy capelin season, the male capelin could be frozen for surimi production during the slower, less busy months of the year. This presents great possibilities for the Newfoundland fishing industry in creating much needed work during the idle winter months, especially in the smaller fish plants dependent on the inshore fisheries.

Properties of Surimi from Other Species

The properties of surimi prepared from redfish (filleted and split), flounder frames and haddock fillets are summarized in Tables 3, 4, 11 and 12. Redfish and haddock surimi have excellent ductility and elasticity (Tables 4 and 11). The preliminary results from flounder frame meat, as with cod frame meat (Table 2), indicate a product with poorer ductility and elasticity than that produced from cod fillets. Generally, frames and split cod from which the kidney region had been

removed, produced better surimi than the frames and split cod from which it had not been removed. Surimi quality was sometimes comparable to that made from fillets. Because of the excellent ductility of surimi cod or fillets, it may be possible to blend surimi from frames with the former and still have a product which meets a particular user's specifications.

One unsuccessful attempt was made to produce surimi from heavily jellied founder (90% moisture content) using the pilot line.

Conclusion

This preliminary study does help establish that good quality surimi can be produced from trawler cod. Generally, surimi quality bears a relationship to the post-mortem age of the cod. Analyses of the cod surimi data have indicated that ductility (torsion shear strain) was influenced by the freshness of the raw material and, to a lesser extent, by the moisture content of the surimi. However, gel strength (torsion shear stress) was not influenced by the freshness of raw material, but was influenced by moisture content.

It was also observed that Grade 2 quality trawler cod with a slight odour can be made into odourless surimi of reasonable quality.

Good quality surimi can be produced from trap cod.

Cod frames and flounder frames, now being treated as waste product, can be potential sources of raw material for producing second grade quality surimi.

Jelly flounder was found to be unsuitable for surimi production.

Haddock produced excellent quality surimi and compared well with that made from cod.

Redfish did produce a good quality surimi. This species could become a good potential source of raw material for surimi production in future.

This study has also established that surimi can be produced from both frozen trawler cod and capelin. This greatly expands the potential use of these species and can have huge economic benefits.

Surimi can be produced from male capelin and this opens up a new avenue for the use of this highly underutilized species. Capelin surimi could be blended with surimi produced from cod, redfish, and flounder to thereby broaden its use.

Acknowledgements

I am grateful to Dr. Norman F. Haard for his advice on the production of laboratory scale surimi and the initial analysis of the surimi data obtained.

I would also like to express my appreciation to Michelle Thompson, Kirk Loveys, and Brian Gillett for their technical assistance and Sheila Gearin for her editing assistance.

Finally, thanks to Dick Whitaker for his encouragement during this project.

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Table 1. Properties of surimi from Atlantic cod harvested by trawl January– March.

Process	Age(days)[1]	N[2]	pH	Lightness[3]	For. Elements	Yield[4]
Lab/Fillet	2–14	10	7.10±0.14	77.7±1.5	7.0±1.3	43.7±2.1
Pilot/Fillet	6–15	13	7.37±0.24	77.8±2.8	9.1±0.3	23.3±4.1
Lab/Frame	7–14	3	7.16±0.08	69.2±0.8	3.0±1.0	5.1±1.8
Pilot/Split	8–13	2	7.08±0.12	72.9±0.2	8.0±0	39.0±5.2

[1] Range of postharvest ice time for eviscerated fish.

[2] Number of batches of surimi prepared by indicated process.

[3] "L" value (0=theoretical black; 93.7= white reference) for gel prepared from surimi cooked at 90°C. Data also available for raw surimi and surimi cooked at 40°C and 60°C.

[4] Yield based on recovery of surimi (80% moisture) from eviscerated fish.

Table 2. Properties of surimi from Atlantic cod harvested by trawl January– March.

Process	Age(days)[1]	N[2]	Moisture(%)	Fold Test[3]	Stress(KPa)[4]	Strain[5]
Lab/Fillet	2–14	10	79.4±.9	5.0±0	28.4±6.5	2.65±.45
Pilot/Fillet	6–15	13	80.8±2.2	3.0±2	9.6±4.5	2.21±.73
Lab/Frame	7–14	3	78.8±2.2	2.0±2	10.3±3.5	1.88±.45
Pilot/Split	8–13	2	79.3±4.7	5.0±0	37.3±24.5	2.48±.13

[1] Range of postharvest ice time for eviscerated fish.

[2] Number of batches of surimi prepared by indicated process.

[3] Fold test for gel cooked at 90°C. Similar results obtained for gels prepared at 40°C and 60°C.

[4] Gel strength measured by Torsion Failure test. Data for gels cooked at 40°C and 60°C are similar.

[5] Ductility measured by Torsion Failure . Data for gels cooked at 40°C and 60°C are similar.

Table 3. Properties of surimi from species other than Atlantic cod.

Fish	Process	Age(days)[1]	pH	Lightness[2]	Foreign Elements	Yield[3]
Redfish	split	5	7.4	75.5	8	n.d.
Redfish	fillet	7	7.5	80.8	9	n.d.
Flounder	frame	11	7.5	70.0	9	10.0
Flounder	frame	12	7.5	70.0	9	12.0
Haddock	fillet	7	7.1	76.3	9	26.4[4]

[1]Estimated time on ice of trawl caught fish.

[2]"L" values for gel cooked at 90°C. Similar results obtained for gels cooked at 40°C or 60 °C.

[3]Yield based on recovery of surimi (80% moisture) from eviscerated fish.

[4]Value based on assumed fillet yield of 50%. Yield of surimi from fillets was 52.7%.

Table 4. Properties of surimi from species other than Atlantic cod.

Fish	Process	Age(days)[1]	Moisture(%)	Fold Test[2]	Stress(KPa)[3]	Strain[4]
Redfish	split	5	80.0	5	27.2	2.91
Redfish	fillet	7	80.4	5	18.1	3.91
Flounder	frame	11	77.1	1	n.d.	n.d.
Flounder	frame	12	77.1	1	29.4	1.81
Haddock	fillet	7	76.1	5	66.0	3.89

[1]Estimated time on ice of trawl caught fish.

[2]Fold test for gel cooked at 90°C. Same results obtained for gels cooked at 40°C or 60 °C.

[3]Gel strength measured by Torsion failure test. Data for gels cooked at 40°C and 60°C similar with exception of flounder surimi which had approximately half the gel strength when cooked At the lower temperatures.

[4]Ductility measured by Torsion failure. Similar results observed for gels cooked at 40°C and 60°C.

TABLE 5 SUMMARY OF SURIMI TEST RESULTS (TRAWLER COD, PILOT SCALE)

SAMPLE	PROCESS DATE	COLOUR "L" VALUE RAW	COLOUR "L" VALUE COOKED (90°)	STRESS (90°C)	STRAIN (90°C)	+ SURIMI YIELD
SPLIT ONE SIDE	April 9, 1986	51.9	73.6	8.5	1.37	20.6
SPLIT ONE SIDE	April 10, 1986	47.7	75.0	8.4	1.78	34.4
SPLIT ONE SIDE	Nov. 19, 1986	49.0	72.6	24.0	3.89	26.5
SPLIT ONE SIDE	Sept. 30, 1966	45.2	71.0	28.1	1.56	29.2
REGULAR SPLIT	Nov. 18, 1986	49.6	75.4	20.1	3.44	28.8
REGULAR SPLIT	June 4, 1986	48.2	74.2	5.0	1.47	25.7
FULL NAPE FILLET (skinless)	Oct. 29, 1986	58.1	77.0	61.3	3.44	20.2
FULL NAPE FILLET (skin on)	Nov. 13, 1986	53.4	75.7	34.6	3.59	19.5
SPLIT, BACKBONE COMPLETELY REMOVED	Nov. 21, 1986	52.9	73.5	17.7	3.06	21.3
COLLAR BONE/NAPES	Dec. 10, 1986	48.7	69.6	54.3	3.14	---
WHOLE COD FRAMES	Oct. 29, 1986	40.5	63.1	15.6	1.34	5.8
TRIMMED COD FRAMES	Oct 30, 1986	48.2	72.2	22.4	1.77	---
SKINLESS FILLET (Previously frozen cod)	Dec. 16, 1986	52.8	77.6	14.3	2.55	28.9

+ Surimi Yield expressed as a percentage of head on gutted fish weight with the surimi moisture content corrected to 80%. Colar bone napes were prewashed for 10 minutes and their minced flesh was washed only once for 5 minutes.

TABLE 6 SUMMARY OF SURIMI TEST RESULTS (TRAWLER COD, LAB SCALE)

SAMPLE	PROCESS DATE	COLOUR "L" VALUE RAW	COLOUR "L" VALUE COOKED (90°)	STRESS (90°C)	STRAIN (90°C)	+ SURIMI YIELD
Straight Cut Fillet	Aug. 19, 1986	61.6	74.7	13.5	1.19	—
Straight Cut Fillet	Aug. 20, 1986	54.7	74.9	14.5	1.21	—
Straight Cut Fillet	Aug. 21, 1986	57.7	76.0	16.2	1.28	36.7
Straight Cut Fillet	Aug. 22, 1986	57.1	74.3	12.1	1.53	37.7
Full Nape Fillet	Sept. 10, 1986	60.3	76.5	14.4	1.51	40.4
Full Nape Fillet	Aug. 20, 1986	58.4	74.3	N/A	N/A	N/A
Full Nape Fillet	Sept. 4, 1986	57.4	76.7	16.4	2.09	40.1
Full Nape Fillet	Sept. 5, 1986	57.7	N/A	28.8	2.35	38.7

+Surimi Yield expressed as a percentage of head on gutted fish weight with the surimi voisture content corrected to 80%

Table 7. DEPENDENCE OF TORSION FAILURE ON WATER CONTENT OF SURIMI AND FRESHNESS OF RAW MATERIAL

Dependent Variable	Independent Variable(s)	$(R^2)^1$	N
Torsion Strain	Postharvest Ice Time(a)	0.25	10(LAB SCALE)
	Surimi water content(b)	0.10	10
	(a) + (b)	0.36	10
	Postharvest Ice Time(a)	0.17	11(PILOT)
	Surimi water content(b)	0.06	11
	(a) + (b)	0.24	11
Torsion Stress	Postharvest Ice Time(a)	0.0	10(LAB SCALE)
	Surimi water content(b)	0.84	10
	(a) + (b)	0.84	10
	Postharvest Ice Time(a)	0.0	11(PILOT)
	Surimi water content(b)	0.82	11
	(a) + (b)	0.82	11

[1] R^2 is coefficient of determination for linear regression analysis of N lots of surimi with indicated dependent and independent variables. Values for (a) + (b) are multipke linear regression analysis. The analyses indicate the **gel strength**(Torsion shear stress) is **not influenced by freshness** of raw material and most of the variation in gel strength can be explained on the basis of surimi moisture content. However, **ductility** (Torsion shear strain) is influenced by freshness of raw material and to a lesser extent by moisture content of the surimi. Other variables, not known at this time, appear to contribute to the variation in ductility observed for these sets of samples. Samples analyzed were lab scale(N=10) and pilot scale(N=11) surimi prepared from fillets.

TABLE 8 SUMMARY OF SURIMI TEST RESULTS (TRAP COD)

SAMPLE	PROCESS DATE	COLOUR "L" VALUE RAW	COLOUR "L" VALUE COOKED (90°)	STRESS (90°C)	STRAIN (90°C)	+SURIMI YIELD
Full Nape (skinless fillet) Pilot	July 23, 1986	54.0	79.8	24.2	2.30	18.8
Full Nape (skinless fillet) Pilot	July 22, 1986	52.3	75.7	23.3	1.90	15.9
Full Nape (skinless fillet) Pilot	July 29, 1986	51.9	73.6	27.4	1.40	21.7
Full Nape (skinless fillet) Pilot	July 30, 1986	53.8	74.5	50.4	2.30	18.9
Straight Cut (skinless fillet) Pilot	July 16, 1986	51.9	63.4	16.6	2.36	19.7
Straight Cut (skinless fillet) Pilot	July 17, 1986	55.0	66.3	4.8	2.20	—
Split One Side Pilot	July 24, 1986	42.7	—	41.7	2.20	28.5
Skinless Fillet Lab	July 21, 1986	50.4	61.6	35.7	2.21	—

+Surimi yield expressed as percentage of head on gutted fish weight with the surimi moisture content corrected to 80%.

TABLE 9 SUMMARY OF SURIMI TEST RESULTS (Capelin, Pilot Scale)

SAMPLE	PROCESS DATE	COLOUR "L" VALUE RAW	COLOUR "L" VALUE COOKED (90°)	STRESS (90°C)	STRAIN (90°C)	[1] SURIMI YIELD
Headless Gutted	July 10, 1986	28.4	40.4	26.5	2.70	18.9
Headless Gutted	June 18, 1986	46.0	—	—	—	26.5
Headless Gutted	June 24, 1986	37.4	46.0	11.0	2.41	17.8
Headless Gutted	June 19, 1986	45.0	53.8	—	—	25.2
Headless Gutted	June 25, 1986	38.5	46.6	11.2	1.1	33.5
Headless Gutted	July 4, 1986	38.4	45.4	4.7	1.5	17.5
Round	June 12, 1986	43.3	49.0	3.6	1.92	21.2

[1] Surimi yield expressed as a percentage of round (whole) fish weight with the surimi moisture content corrected to 80%.

TABLE 10 SUMMARY OF SURIMI TEST RESULTS (Capelin, Lab. Scale)

SAMPLE	PROCESS DATE	COLOUR "L" VALUE RAW	COLOUR "L" VALUE COOKED (90°)	STRESS (90°C)	STRAIN (90°C)	[1]SURIMI YIELD
Headless Gutted (Frozen Capelin)	July 8, 1986	26.1	44.8	9.2	1.03	36.8
Headless Gutted (Frozen Capelin)	Oct. 6, 1986	30.2	41.5	14.6	0.74	46.3
Headless Gutted (Frozen Capelin)	Oct. 8, 1986	29.6	42.1	—	—	49.6
Headless Gutted (Frozen Capelin)	Oct 9, 1986	30.2	42.7	5.5	1.03	37.9
Round	Oct. 7, 1986	26.5	39.3	13.3	0.85	57.8
Skinless Fillet	July 1, 1986	34.6	47.9	5.8	1.83	15.4
Headless Gutted (Fresh Sample)	July 3, 1986	33.9	45.6	—	—	37.9

[1]Surimi yield expressed as a percentage of round (whole) fish weight with the surimi moisture content corrected to 80%.

TABLE 11 SUMMARY OF SURIMI TEST RESULTS (Redfish, Pilot Scale)

SAMPLE	PROCESS DATE	COLOUR "L" VALUE RAW	COLOUR "L" VALUE COOKED (90°)	STRESS (90°C)	STRAIN (90°C)	[1] SURIMI YIELD
Skin on Fillet	Sept. 18, 1986	56.2	70.8	48.6	2.61	14.2
Skin on Fillet	Sept. 19, 1986	55.5	73.3	42.1	2.73	14.0
Skin on Fillet	Sept. 23, 1986	55.4	70.7	45.7	3.23	13.9
Skin on Fillet	Sept. 24, 1986	51.7	—	51.4	2.46	11.7
Skin on Fillet	Sept. 25, 1986	49.4	68.6	46.4	2.11	13.7
Skin on Fillet	Sept 26, 1986	50.7	67.5	45.1	2.36	13.4

[1]Surimi yield expressed as a percentage of round (whole) fish weight with the surimi moisture content corrected to 80%.

TABLE 12 SUMMARY OF SURIMI TEST RESULTS (Flounder)

SAMPLE	PROCESS DATE	COLOUR "L" VALUE RAW	COLOUR "L" VALUE COOKED (90°)	STRESS (90°C)	STRAIN (90°C)	+SURIMI YIELD
Whole Frame (Lab Scale)	Aug. 13, 1986	61.7	75.6	8.6	2.54	16.2
Trimmed Frame (Pilot Scale)	Oct. 30, 1986	64.6	75.0	22.3	1.24	—

+Surimi yield expressed as a percentage of head on gutted fish weight with the surimi moisture content corrected to 80%.

Appendix A. Summary of Test Results of Pilot Scale Surimi Produced from Cod Fillets.

Sample	Process Date	Moisture Content	pH	Colour ("L" Value)				Fold Test			Foreign Elements	Surimi Yield 80% Moisture Content	Stress (KPA)			Shear Strain		
				Raw	40°C	60°C	90°C	40°C	60°C	90°C			40°C	60°C	90°C	40°C	60°C	90°C
Cod, 6 day old	Mar.12/86	80.5	7.3	55.4	78.5	80.1	81.3	5	5	5	9	28.92	17.4	11.1	13.0	2.16	1.92	1.87
Cod, 7 day old	Mar.13/86	78.6	7.2	-	-	-	-	5	5	5	9	28.2	37.0	28.5	25.2	2.85	2.50	2.28
Cod, 8 day old	Feb.25/86	81.3	7.3	51.8	80.2	80.1	80.3	5	5	5	9	23.9	22.2	19.2	17.6	3.80	2.69	2.98
Cod, 9 day old	Feb.26/86	82.9	7.3	55.5	81.3	80.0	78.6	5	5	5	9	22.4	11.0	6.3	7.1	3.73	4.26	3.27
Cod, 10 day old	Feb.27/86	81.4	7.3	52.9	78.9	76.7	79.7	2	4	1	10	26.4	7.4	6.2	9.1	2.17	1.99	1.89
Cod, 11 day old	Feb.28/86	85.9	7.9	53.0	79.0	79.4	79.4	1	1	1	9	10.9	-	-	-	-	-	-
Cod, 11 day old	Mar. 7/86	81.6	7.6	48.8	77.6	76.4	77.5	1	1	1	9	13.2	-	5.5	14.5	-	1.51	1.93
Cod, 11 day old	Mar.19/86	82.4	7.7	57.6	82.1	81.1	80.5	5	5	5	9	23.6	5.3	6.2	6.8	1.80	2.15	2.17
Cod, 12 day old	Feb.19/86	74.8	7.0	53.0	74.6	74.3	76.0	5	5	5	9	27.4	66.7	70.3	79.3	2.59	3.26	3.11
Cod, 12 day old	Mar.20/86	81.7	7.3	-	-	-	-	5	5	5	9	27.7	7.3	8.1	8.1	1.68	1.76	1.84
Cod, 14 day old	Mar. 3/86	80.3	7.8	55.9	78.3	77.6	77.4	1	1	1	9	24.9	4.4	3.5	3.5	1.19	1.28	1.28
Cod, 14 day old	Mar.10/86	81.4	7.6	-	-	-	-	1	1	1	9	21.0	12.0	8.3	10.2	1.63	1.44	1.45
Cod, 15 day old	Mar. 4/86	80.3	7.2	54.2	78.1	77.0	72.1	1	1	1	9	23.1	-	-	-	-	-	-
*Trap Cod 1 day old	Aug./85	76.1	6.3	58.6	76.0	74.6	74.8	4	1	1	7	-	22.8	9.2	18.9	1.89	1.38	1.72

*A surimi sample produced commercially from Trap Cod in the plant at Terra Nova Fisheries, Clarenville, Nfld.

A Study of Yields of Surimi produced from Selected Atlantic Fish Species

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The surimi yields from trawler cod, trap cod, capelin, redfish and flounder in laboratory and pilot scale production are summarized in Tables 1 to 11.

The yield of surimi fillets was much greater in the laboratory scale process than it was in the pilot scale process (Table 1). The poorer yield with the pilot surimi line appears to be due to losses of finer particles during dewatering. However, fairly good yields were obtained from split cod with the pilot line. The yield of surimi (without cryoprotectants) from trap cod was approximately 65% of fillet meat (Haard & Warren, 1986). Assuming a skin-on-fillet yield of 45% from eviscerated, (i.e., dressed) cod, this would indicate an approximate surimi yield (with cryoprotectants) of 34% from eviscerated trap fish. The trap cod surimi yields for pilot scale production ranged from 14% to 22% of dressed weight. The yield achieved from commercially produced surimi by Terra Nova Fishery varied from 35% to 45% of trap cod fillet weight (David Ho - Personal Communications). This translated to 16% to 20% of eviscerated cod weights which was lower than the average yield of 23.3% obtained in the pilot scale surimi produced from trawler cod fillets in the present study. The somewhat lower yield of surimi from trap cod is consistent with the higher content of myofibrillar protein in winter fish (Physiology studies Haard, 1986).

The surimi yield produced on the pilot line from headed and gutted capelin ranged from 18% to 34% of round weight compared with the much higher range from 35% to 50% of round weight in the laboratory scale study. In the pilot scale capelin surimi production, the average yield was 23.3% of round weight compared to 42% of round capelin weight in laboratory scale surimi production. In this study all surimi yields have been expressed at 80% moisture content as a percentage of eviscerated (i.e., dressed) cod weight, unless otherwise stated.

Surimi produced from "split" cod on the pilot line was promising. Its quality was good to excellent. The yield, in fact, was about twice as good as that normally obtained commercially from trap cod fillet at Terra Nova Fishery. Admittedly, further refinements need to be sought, but the present study does indicate that "split" cod as a raw material would be much cheaper and easier to process than cod fillet in the production of surimi.

There was quite a difference in surimi yield between the laboratory and pilot scale production. The laboratory scale does indicate the possible maximum potential yield attainable. Improvements in the pilot line, in terms of wastage encountered during processing, warrants further investigation. Possibly, a finer screen in the screw press or screening or centrifuging press waste water and recycling the fines through the press could help improve yield.

The yield of surimi prepared from trawler cod tended to decrease with post-harvest age of the raw material, more so for pilot scale surimi than for laboratory scale surimi (Figure 1). Further pilot scale studies with cod less than 6 days old may indicate marked improvement in yield. It is possible that very fresh fish, when processed with the pilot line, may produce greatly improved surimi yields.

A comparison of surimi yield studies between a pilot scale and laboratory scale production is shown in Table 3. As can be seen, under controlled laboratory scale surimi production, it was possible to achieve a yield of 47.6% of eviscerated cod weight from full naped fillets and a yield of 6.8% of eviscerated cod from cod frames with the backbone around the kidney region removed. A surimi yield of 34.4% of eviscerated cod was obtained on the pilot line using "split" cod. During this particular process, as shown in Table 3, 17.5% of eviscerated cod weight was lost as minced waste, 3.7% lost as refiner waste; 5.7% lost as screw press waste; 1.1% lost as surimi still stuck inside the screw press and 22.4% lost due to the cod's head which was not used in the surimi process. Therefore, the unaccounted loss (due to soluble proteins, fats, and bits and pieces of fish flesh stuck to the pilot line machinery) was about 15.2% of eviscerated weight. Assuming that the laboratory scale surimi yields obtained from both the cod fillet and the frames were about the full potential of what could be achieved in terms of the total yield of cod, then the pilot scale surimi performance worked out to be about 63% of laboratory scale surimi production.

FIGURE 1

YIELD OF SURIMI (80% WATER)

ATLANTIC COD

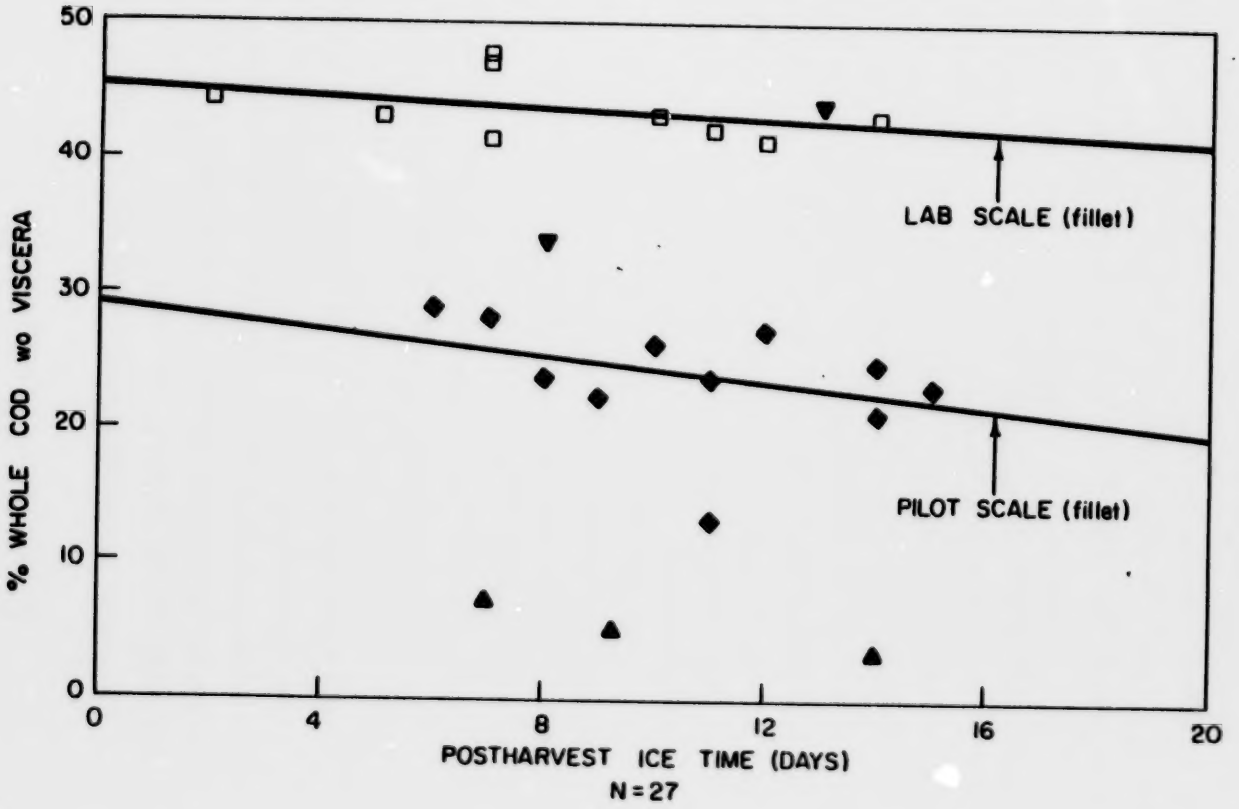

TABLE 1

Table 1. Properties of Surimi from Atlantic Cod Harvested by Trawl, January-March

Process	Age (days)[1]	N[2]	pH	Lightness[3]	Foreign Elements	Yield[4]
Lab/Fillet	2-14	10	7.10 ± 0.14	77.7 ± 1.5	7.0 ± 1.3	43.7 ± 2.1
Pilot/Fillet	6-15	13	7.37 ± 0.24	77.8 ± 2.8	9.1 ± 0.3	23.3 ± 4.1
Lab/Frame	7-14	3	7.16 ± 0.08	69.2 ± 0.8	3.0 ± 1.0	5.1 ± 1.8
Pilot/Split	8-13	2	7.08 ± 0.12	72.9 ± 0.2	8.0 ± 0	39.0 ± 5.2

1 Range of postharvest ice time for eviscerated fish.

2 Number of batches of surimi prepared by indicated process.

3 "L" value (0 = theoretical black; 93.7 = white reference) for gel prepared from surimi cooked at 90°C. Data also available for raw surimi and surimi cooked at 40°C and 60°C

4 Yield based on recovery of surimi (80% moisture) from eviscerated fish.

TABLE 2

BREAKDOWN OF YIELD LOSSES IN A PILOT SCALE SURIMI PRODUCTION FROM "SPLIT" COD

Sample: "Split" Cod, post-mortem age of 4 days.

Process Date: April 10, 1986

POINT OF LOSS	PERCENT LOSS OF DRESSED WEIGHT (80% MOISTURE)
FISH HEAD	22.4%
MINCER WASTE (SKIN & BONES)	17.5%
REFINER WASTE	3.7%
SCREW PRESS WASTE	5.7%
SURIMI STUCK TO SCREW PRESS	1.1%
SURIMI YIELD	34.4%
UNACCOUNTED LOSS (SOLUBLE PROTEINS, FATS & FLESH STUCK TO PILOT LINE)	15.2%

TABLE 3

COMPARISON OF SURIMI YIELDS IN A PILOT AND LABORATORY SCALE PRODUCTION (1)

LAB SCALE SURIMI YIELD FROM COD FILLET (7 DAYS OLD) PROCESS DATE: JAN. 14/86	47.6%
LAB SCALE SURIMI YIELD FROM COD FRAMES (7 DAYS OLD) PROCESS DATE: JAN.14/86	6.8%
PILOT SCALE SURIMI YIELD FROM "SPLIT" COD (4 DAYS OLD) PROCESS DATE: APRIL 10/86	[illegible].4%

(1) Surimi yields expressed as a percentage of dressed cod weight and corrected to 80% moisture content.

Table 4

TRAWLER COD PILOT

Sample	Process Date	Age Days	Yield (80%) As per Raw Material	Yield (80%) Based on HOG Wt.
Full Nape Skinless Fillet	Oct. 29	5	43.0	20.2
Skin-On, Full Nape Fillet	Nov. 13	6	--	19.5
Regular Split	Nov. 18	5	--	28.8
	June 4	?	--	25.7
Split One Side	April 9	3	--	20.6
	April 10	4	--	34.4
	Nov. 19	5	--	26.5
	Sept. 30	5	--	29.2
Split, Backbone Completely Removed	Nov. 21	5	--	21.3
Collar Bone Napes	Dec. 10	5	--	--
Whole Cod Frames	Oct. 30	5	42.3	5.8
Trimmed Cod Frames	Oct. 30	5	25.6	--
Skinless Fillet	Dec. 16	?	--	28.9

Table 5

TRAWLER COD LAB SCALE

Sample	Process Date	Age Days	Yield (80%) As per Raw Material	Yield (80%) Based on HOG Wt.
Straight Cut Fillet	Aug. 19	5	--	--
	Aug. 20	6	--	--
	Aug. 21	7	--	36.7
	Aug. 22	8	--	37.7
Full Nape	Sept. 10	5	--	40.4
	Aug. 26		--	--
	Sept. 4	8	--	40.1
	Sept. 5	10	--	38.7

Table 6

TRAP COD PILOT

Sample	Process Date	Age Days	Yield (80%) As per Raw Material	Yield (80%) Based on HOG Wt.
Full Nape Skinless Fillet	July 28		12.1	13.8
	July 22	1	13.9	15.9
	July 29	2	19.0	21.7
	July 30	3	16.6	18.9
Straight Cut Skinless Fillet	July 16	1	19.9	19.7
Split One Side	July 24	1	24.9	28.5

Table 7

TRAWL COD (INSHORE) PILOT SCALE

Sample	Process Date	Age Days	Yield (80%) As per Raw Material	Yield (80%) Based on HOG Wt
Regular Split	Oct. 15	1	--	31.4
Split One Side	Oct. 16	2	--	33.7
Split, Backbone Completely Removed.	Oct. 17	3	--	29.6

Table 8

CAPELIN PILOT SCALE

Sample	Process Date	Age Days	Yield (80%) As per Raw Material	Yield (80%) Based on HOG Wt
Round	June 12	2	--	21.2
Headless Gutted	July 10	2	--	18.9
	June 18	2	--	26.5
	June 24	1	--	17.8
	June 19	2	--	25.2
	June 25	1	--	33.5
	July 4	2	--	17.6

Table 9

CAPELIN LAB SCALE

Sample	Process Date	Age Days	Yield (80%) As per Raw Material	Yield (80%) Based on HOG Wt.
Round	Oct. 7		--	57.8
Skinless Fillet	July 1	1	--	15.4
Headless Gutted (Fresh)	July 3	3	37.9	--
Headless Gutted (Fresh)	July 8	6	--	36.8
	Oct. 6 (Frozen July 2/86)		--	46.3
	Oct. 8 (Frozen July 2/86)		--	49.6
	Oct. 9 (Frozen July 2/86)		--	37.9

Table 10

REDFISH PILOT SCALE

Sample	Process Date	Age Days	Yield (80%) As per Raw Material	Yield (80%) Based on HOG Wt.
Skin-On Fillet	Sept. 18	4	--	14.2
	Sept. 19	5	--	14.0
	Sept. 23	6	--	13.9
	Sept. 24	7	--	11.7
	Sept. 25	8	--	13.7
	Sept. 26	9	--	13.4

Table 11

FLOUNDER PILOT SCALE

Sample	Process Date	Age Days	Yield (80%) As per Raw Material	Yield (80%) Based on HOG Wt.
Whole Frame	Oct. 30	?	25.2	--
Trimmed Frame	Nov. 4	?	13.9	--

Surimi Technology Applied to Underutilized Species

by

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Canadian Institute of Fisheries Technology

Technical University of Nova Scotia*

Introduction

The objective of the current surimi research program at the Technical University of Nova Scotia (TUNS) is to investigate technical problems associated with surimi manufacturing from underutilized, low-value species of the Atlantic Canadian fishery. The Canadian Institute of Fisheries Technology (CIFT) became involved in this field in 1983 when it prepared a comprehensive global review of the surimi industry and assisted in preparation of a report for the Newfoundland Fisheries Development Branch on the developmental potential of surimi in Atlantic Canada. In 1985, we began producing surimi on a pilot plant scale from herring, dogfish, hake and cod; now we are refining the work, using both laboratory and pilot plant production techniques. Funding to support our research has come from Fisheries and Oceans through the Department of Supply and Services, Halifax, and also the Natural Sciences and Engineering Research Council (NSERC). We expect to continue making progress in this field and have obtained NSERC funding through 1988.

The topic which CIFT has been asked to address at this workshop is the acceptability of raw material for surimi. This is of course something that we are currently studying in our research program. Because this work is still in progress, we believe it is too early to provide a simple answer, that is, to rule out any specific resource as being

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unacceptable for surimi. It may be simply that the appropriate manufacturing techniques have not yet evolved.

In discussing the surimi potential of various fish species, we must consider how we define "acceptability". Although certain species may not be suitable for kamaboko style seafood analogs, stabilized intermediate products with functional properties may be quite useful and attractive to the prepared meat and snack food industries.

Over the next few minutes, I will be presenting some of the data gathered from our studies aimed at optimizing the quality and yield of surimi from herring, mackerel, hake and dogfish. Once we have completed this stage of the research, we will be able to more comprehensively report on the acceptability and surimi potential of these Atlantic species.

FIGURE I

UNDERUTILIZED SPECIES

Herring	- *Clupea harengus harengus*
Mackerel	- *Scomber scombrus*
Dogfish	- *Squalus acanthias*
Red Hake	- *Urophycis chuss*
Silver Hake	- *Merluccius bilinearis*

Methods and Materials

Experimental Strategy and Approach

Our initial literature search determined the current "state of the art" for surimi production from non-typical species. The Japanese have, of course, utilized many different fish in their studies and have published surimi manufacturing techniques for fatty as well as lean species. Our strategy at CIFT has been to build upon this existing technology. We have been testing and modifying some of the Japanese methods with the goal of developing a process which will consistently optimize the quality of surimi from Atlantic fatty fish. For lean species, i.e., hake, cod and Atlantic pollock, our strategy has been to improve on the basic Alaska pollock process by modifying the processing parameters, i.e., wash water pH, additive levels, wash time and water to mince ratio.

FIGURE 2

METHODS

Fish Quality and Freshness - Woyewoda et. al., 1986

Proximate Analysis

Tissue pH

Free Fatty Acit

Thiobarbituric Acid

Physical Attributes

Manufacturing techniques specific to different species were established in bench scale experiments before proceeding with pilot plant trials. We have found that this approach works well; bench scale experiments are efficient, use little material, and allow for accurate control and study of the surimi manufacturing process. Subtle changes in the

material character, critical to gaining an insight into the process, can sometimes be overlooked during full-scale pilot runs.

In order to assess the importance of "freshness" of the raw material, we try to obtain the best quality, freshest fish possible and then use it in trials over several successive days. Samples of the deboned mince from each production day are taken for proximate analysis and stabilized as frozen extracts, for subsequent analysis of quality including free fatty acid and thiobarbituric acid values. This allows us to accurately establish the quality of the raw materials on each processing day.

Surimi Quality Assessment

The laboratory techniques used to evaluate the appropriateness of a processing method and the surimi quality are:

- Surimi Proximate Analysis - Woyewoda et al., 1986
- Gel Forming Ability
  - Fold Score - Toda et al., 1971
  - Gel Strength, Instron Punch Test - Lee, 1984
  - Expressible Moisture - Adapted from Lee and Toledo, 1976
- Gel Color - Gardner Color Difference Meter
- Gel Odor and Flavor
- Surimi pH
- Wash Water Protein content - Biuret or Kjeldahl Methods
- Product Yield

Gels are prepared either in a small domestic food processor or Hobart silent cutter (model 84145) with 3% NaCl, and extruded into 30 mm diameter pyrex tubes. Generally three different gel setting regimes are followed, i.e., gelling at room temperature (20°C for 18 hours), a standard cook specified by the Japanese protocol (90°C for 30 mins.)

and two temperature method (40°C for 30 mins. followed by 90°C for 20 mins.) which allows one to assess the "suwari" or low temperature setting characteristics of the surimi (Lanier, 1985). The gels are cooked in water baths and analyzed in triplicate within 48 hours.

Results

Herring (Clupea harengus harengus)

The process which has produced the highest quality herring surimi in our laboratory and pilot plant trials is as follows:

Headed and Gutted Fish
↓
Meat Bone Separator - 5 mm Drum
↓
Soaked 1:5 in 0.5% $NaHCO_3$ 15 mins. ⟶ Fat Skimmed.
↓
Dewatered
↓
Washed 1:3 in 0.3% NaCl @ pH 6.2-6.3 2x5 mins. ⟶ Fat Skimmed.
↓
Centrifuged
↓
Strained - 2 mm Screen
↓
Cryoprotectants Added
↓
Frozen

Soaking of the deboned mince in $NaHCO_3$ increases the pH of the tissue to above 7.2 thereby swelling the proteins. This appears to augment removal of the lipids and also assists in bleaching the product. Food grade phosphoric acid is used to drop the pH during the subsequent leaching steps. Washing the herring in 0.3% NaCl at the reduced pH allows for efficient dewatering and extraction of water soluble proteins. Maintaining the temperature of the mince at less than 10°C throughout the entire manufacturing process is critical to preserving the functionality of the muscle proteins.

FIGURE 3

HERRING PROCESS DEVELOPMENT

Uncut Roe Herring - 1 day old
pH: 6.55 TBA: 30.6 u moles/kg fish
%H_2O: 76.5 FFA: 2.2% as oleic acid

Process	Surimi %H_2O	Surimi %Fat	Color L Value	%Expressible H_2O/%Total	Strength Avg.g-cm	Yield Washed Mince
Soaked 30 mins. in 0.5% $NaHCO_3$ Wash pH - Endogenous Strained ⟶ Dehydrated in Muslin	76.2	2.11	62.7	47.0	120	39.6
Soaked 30 mins. in 0.5% $NaHCO_3$ Wash pH - Adjusted to 6.2 Centrifuged ⟶ Strained	80.5	3.19	66.1	44.3	180	40.5
Soaked 15 mins. in 0.5% $NaHCO_3$ Wash pH - Endogenous Strained ⟶ Centrifuged	82.6	2.47	64.0	50.5	240	19.5

The quality of herring surimi, even from very fresh fish, has been inconsistent; however, functional products with high gel strengths (up to 420 g-cm) have been achieved in some runs. Variability in the raw material and the rapid loss of gel forming ability are major problems with herring. Punch scores decrease by approximately 50% for every day the fish is held on ice to less than 100 g-cm for 3-day-old herring.

We consider the color of cooked herring surimi to be quite acceptable. Gardner color difference meter L values averaged 64.0 for roe herring and 67.1 to 70.6 for gels prepared from high fat food grade fish.

Sensory attributes of the surimi depended on the quality of the raw material. Odor and flavor of the gels from high quality herring surimis were mild and agreeable. Although the processing method reduces the fat content of the product to approximately 3% in roe

herring surimi and 6.4% in surimi from fatty food grade fish, rancidity is a potential problem with this commodity. The use of antioxidants should prevent lipid oxidation.

FIGURE 4

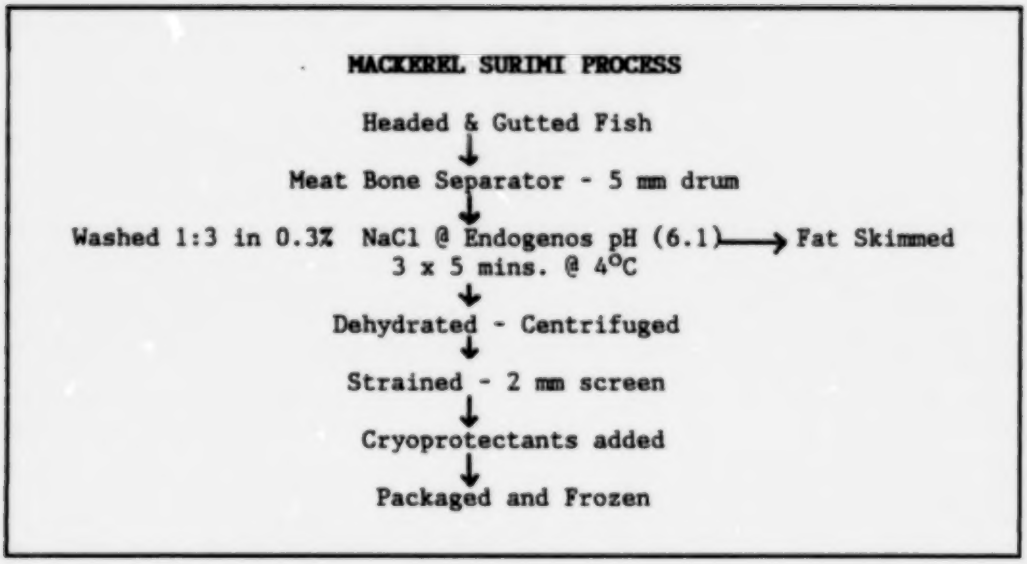
HERRING

Raw Material	Days on Ice	Mince pH	Mince % Fat	Surimi $\%H_2O$	Surimi %Fat	Cooked Gels Color L Value	Cooked Gels Gel Strength Avg. g -cm
ROE HERRING							
Fillets only Aug. 28, 1986	1	6.6	4.3	78.5	2	68.6	390
Deboned Mince Sept. 30, 1986	1	6.6	7.4	82.6	2.47	64.0	240
FATTY-FOOD GRADE							
Deboned Mince Oct. 29, 1986	2	6.6	14.3	75.3	6.2	67.1	350
Oct. 30, 1986	3	6.6	14.3	74.2	8.3	69.0	92

Mackerel (Scomber scombrus)

As with herring, we have tested several different methods of making mackerel surimi. The technique developed for herring was successful in producing a moderately good quality mackerel surimi; however, a straightforward process, employing 3 washes in 3 volumes of 0.3% NaCl, resulted in products with slightly higher gel strengths. The pH of the wash water was not adjusted, but left at the natural endogenous level, 6.1-6.2. Japanese research indicates that allowing the tissue pH to fall below this range will result in a decrease in the functional properties of fish proteins.

FIGURE 5


MACKEREL SURIMI PROCESS
Headed & Gutted Fish
Meat Bone Separator - 5 mm drum
Washed 1:3 in 0.3% NaCl @ Endogenos pH (6.1)
3 x 5 mins. @ 4°C
Fat Skimmed
Dehydrated - Centrifuged
Strained - 2 mm screen
Cryoprotectants added
Packaged and Frozen

Excellent quality trap mackerel were obtained for use in our experiments. One-day-old fish, still in rigor, produced good quality surimi with gel strength values averaging 330 g-cm. As with most Atlantic species, the double heat treatment which allows the gel to preset at 40°C prior to a final cook at 90°C resulted in stronger more deformable gels. The "suwari" gels of mackerel surimi are quite elastic. High punch test scores (up to 430 g-cm) were obtained when the gels were allowed to form at room temperature.

A time study examining the "freshness" requirements for mackerel surimi has been carried out, however, the products have not yet been fully analyzed. Preliminary data indicate that this species appears to retain its functional properties somewhat longer than herring. Surimi from 4-day-old iced mackerel resulted in gel strengths averaging 140 g-cm.

Sensory quality of the cooked mackerel gels was lower than that of herring surimi; color was darker (L values 65.0-66.9) and the fishy odor somewhat stronger.

Proximate composition of the mackerel product varied according to the processing methods and efficiency of dewatering. Fat content of the mince was reduced from an initial level of 10.2% to approximately 3%. Surimi moisture content averaged 80%.

FIGURE 6

MACKEREL SURIMI QUALITY

Process	Days on Ice	Surimi %H_2O	Color L Value	Fold #	%Expressible H_2O/%Total	Gel Strength Avg. g-cm
A-Washed 3x in brine	1	79.9	65.0	6	44.3	330
B-Herring Method	1	78.3	64.9	6	38.2	270
B-Herring Method	2	80.8	64.7	6	56.4	74
C-Herring Method with a 3rd brine wash @ pH 6.3	3	79.7	65.7	6	45.3	150
B-Herring Method	4	78.6	65.4	6	42.8	150
A-Washed 3x in brine	4	79.7	66.5	6	50.4	140

Dogfish (Squalus acanthias)

To date we have had very little success producing a functional surimi from dogfish. A variety of methods have been tested, but none has proven acceptable. Although Japanese researchers have utilized shark meat, the surimi processing techniques recommended did not work in our

trials. Nevertheless, we are not yet eliminating dogfish from the list of potential surimi source species. At this time, it is believed that a more fundamental approach toward the dogfish work must be taken. Our future research will be aimed at investigating the composition and biochemistry of dogfish proteins.

FIGURE 7

JAPANESE DOGFISH SURIMI PROCESS

Headed & Gutted Fish

Meat Bone Separator

Soak 1:5 at 1.0% $NaHCO_3$ - 20 mins.

Wash 2-5 times 1:3 in Cold Water @ pH 6.6

Last Wash @ pH 6.6 in 0.15% NaCl

Dehydrate

Strain

Cryoprotectants added

Package and Freeze

FIGURE 8

DOGFISH SURIMI

Process	Days on Ice	Mince			Surimi		Cooked Gels Gel Strength g -cm	Yield %Wt. Fr. Mince
		pH	%H_2O	%Fat	%H_2O	%Fat		
Washed 3x in H_2O	1	6.0	74.8	9.0	76.6	7.1	<10	34
Washed 2x in H_2O 3rd wash in brine	3	6.0	--	--	78.3	5.7	<10	17
Soaked in $NaHCO_3$ washed 2x in H_2O	3	6.1	74.1	12.8	78.0	8.0	--	15

Hake (Urophycis chuss and Merluccius bilinearis)

Our work with hake is still in the early stages. A year ago we completed one set of experiments with red hake; another trial with silver hake was carried out last September. Unfortunately, the fish available for these runs had been held approximately 5 days prior to receipt and were not in good condition.

FIGURE 9

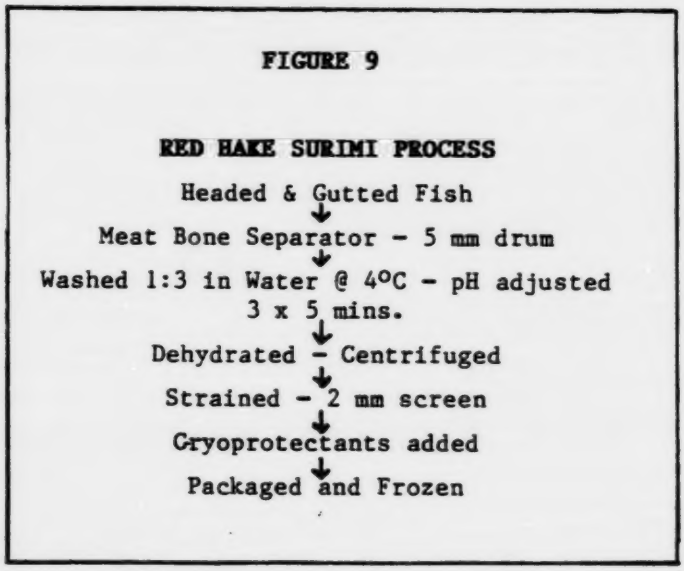

RED HAKE SURIMI PROCESS
Headed & Gutted Fish
Meat Bone Separator - 5 mm drum
Washed 1:3 in Water @ 4°C - pH adjusted
3 x 5 mins.
Dehydrated - Centrifuged
Strained - 2 mm screen
Cryoprotectants added
Packaged and Frozen

FIGURE 10

RED HAKE

Materials and Process	Composition %H_2O	%Protein	% Fat	Color L Value	Cooked Gels Fold#	Strength g-cm
Deboned Mince 5-7 day old fish	83.9	20.4	1.0	50.0		
Surimi washed @ pH 6.7 (Endogenous)	84.3	10.4	0.4	58.1	5	30
washed @ pH 6.1	81.8	15.1	0.5	57.6	4	110

As mentioned earlier, the method used to make surimi from lean fish is basically an Alaska pollock process. With silver hake, washing 3 times in dilute brine at a reduced pH produced the highest quality product.

Although our research with hake has been limited, the results indicate that even poor quality raw material can successfully produce surimi with some gelling capabilities. This finding has been supported by Lanier's group at the North Carolina State University and Dr. Lee at the University of Rhode Island. Lanier (1984) recommends rapid gutting and removal of the napes for optimizing the gelling ability of these products.

Color, odor and flavor of the hake surimi gels were excellent, being quite similar to that obtained with cod. L values for the cooked product averaged 69.3.

FIGURE 11

SILVER HAKE PROCESSING STUDY

Material and Process	Composition %H_2O	%Fat	Color L Value	Fold #	%Expressible H_2O/%Total	Gel Strengt Avg. g-cm
Deboned Mince						
5 day old fish Endogenous pH:6.5	82.1	1.84				
Surimi						
NaCl - 3rd wash only @ Endogenous pH - 6.5	81.5	1.13	69.3	6	54.9	130
Washed 3x in brine @ pH 6.5	79.9	1.37	69.8	6	40.7	160
Washed 3x in brine @ pH 6.1	79.9	1.40	69.3	6	41.1	210

FIGURE 12

Surimi Quality and Yield from Pilot Plant Studies
on Various Atlantic Species

Raw Material	Days on Ice	Mince $\%H_2O$	Surimi $\%H_2O$	Color L Value	Gel Strength Avg. g-cm	Yield % by Wt. Round fish	Yield % by Wt. Gutted fish
Food Grade Herring Oct. 29, 1986	2	67.4	75.3	67.1	350	27	
Mackerel Nov. 18, 1986	1	68.6	79.9	65.0	330	30	
Dogfish Nov. 29, 1985	2	74.8	76.6	--	<10	10	
Red Hake Feb. 24, 1985	6	83.9	81.8	--	110		38
Silver Hake Sept. 9, 1986	5	82.1	79.9	69.3	210		16
Cod May 7, 1986	1	81.7	82.0	77.1	670		30

Conclusions

In conclusion, both red and silver hake appear to be suitable for use in a variety of kamaboko style products and could serve as a resource for top quality SA grade surimi. Mackerel and herring can also be used to make good quality, functional ingredients or products. The basic technology for producing surimi from these species has already been established. Research aimed at optimizing the processes is underway.

The acceptability of dogfish as raw material for surimi manufacturing is questionable. A considerable amount of research will be required before dogfish surimi is feasible.

At CIFT, we believe that the success of a surimi industry in Atlantic Canada will depend upon the raw material freshness requirements, as well as the industry's ability to work out the logistics of fish procurement. One of CIFT's major areas of research in the future will be to examine the acceptability of frozen fish as a surimi resource.

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TYPICAL ANALYSES OF SURIMI RAW MATERIALS AND PRODUCTS

		FISH MINCE			SURIMI COMPOSITION		COOKED GELS COLOR	GEL STRENGTH G-CM			YIELD - % WT.
RAW MATERIAL	AGE DAYS	pH	% H_2O	% FAT	% H_2O	% FAT	L VALUE	FOLD #	AVG.	MAX.	FROM MINCE
ROE HERRING											
Sept. 30, 1986	1	6.6	76.5	7.4	82.6	2.5	64.0	6	240	290	55
FOOD GRADE HERRING											
Oct. 29, 1986	2	6.6	67.4	14.3	75.3	6.2	67.1	5	350	420	50
Oct. 30, 1986	3	6.6	67.4	14.3	74.2	8.3	69.0	4-5	90	110	50
MACKEREL											
Nov. 18, 1986	1	6.1	68.6	10.2	79.9	2.8	65.0	6	330	360	55
Nov. 21, 1986	4	6.2	71.1	9.4	79.7	2.8	66.5	6	130	140	58
DOGFISH											
Aug. 19, 1986	3	6.1	73.3	12.8	78.0	8.0	-	Mince lost during washing			15
Nov. 29, 1985	2	6.0	74.8	9.0	76.6	7.1	85.5	1	<10	<10	34
RED HAKE											
Feb. 24, 1985	6	6.7	83.9	1.0	81.8	0.5	-	4	110	130	77
SILVER HAKE											
Sept. 9, 1986	5	6.6	82.1	1.0	79.9	0.4	69.3	6	210	250	54
COD											
May 7, 1986	1	7.3	81.7	1.1	82.0	0.3	77.1	6	670	810	62

Surimi Process Controls

by

Mike Hawco and Dr. Ernest Reimer

CAMPOLAR Consultants

The development of process controls for the surimi industry requires a basic understanding of the principles underlying each step in the process. What makes the surimi process different and more difficult to control than other fisheries processes is that it involves, not only physical operations such as gutting, icing, mincing, etc., but also a new dimension, manipulation of proteins. When processing surimi, the end product will vary tremendously, depending on the nature of the raw material used. Generally, fresher fish makes better surimi, but this basic premise sometimes fails even though processing conditions remain constant. How can such a process be controlled? How can a processor expect to produce a consistent product? What distinguishes one starting material from another? What conditions need to be changed in order to produce a consistent quality product?

The basic surimi process is relatively simple and can be carried out in the kitchen using fish, fresh water, a bucket, a knife and a filter cloth. The process involves cutting the fish into small pieces, washing it liberally with water and pressing out excess water.

The Japanese have been making kamaboko, or cooked surimi, for 800 years (Figure 1). Using crude implements, kamaboko was made by catching and cleaning the fish, followed by mincing, washing, dewatering, adding salt, chopping and, finally, cooking the mince. With increasing popularity and demand, technologies were developed to produce surimi on a larger scale (Figure 2). As can be seen in this Figure, fish still undergoes the same process of mincing, washing, dewatering and cooking; the only difference in the original method is the rate of production and the manpower required.

With this degree of automation, one might think that production of consistent product would be assured, but experience has shown that such is not the case. Producing consistent quality from a variety of starting materials requires an understanding of both the process and the starting material. Originally it was believed that with the surimi process there was an absolute requirement for freshness--the best Japanese surimi is said to be made at sea. Recent pilot experiments at the Marine Institute have shown that first-grade material can be made from 9-day trawler cod. On other occasions, much fresher fish has produced a poorer grade of surimi. The major variable in the process is the "biochemical condition of the protein". Successful control of the process, therefore involves:

1. identification of the functional state of the muscle protein, and
2. manipulation of the various process parameters to optimize the state of the muscle protein.

In this presentation, we will explain the surimi process in terms of refinement of fish muscle protein, and, then, outline how this basic understanding of biochemistry can help us make educated decisions when processing.

Surimi and Protein Extraction

Surimi is usually made from the edible portion of the fish, i.e., the fillet. Figure 3 shows that, besides the water, the fillet of a cod is primarily protein (20%). Other more fatty species such as herring or mackerel, may contain up to 20% fat as well as the protein. In this case, protein will still be approximately 20% and the remainder will be water. Dark flesh has a higher fat content than white flesh. The majority of the 20 per cent protein is preserved following surimi processing.

As shown in Figure 4, the 20 per cent protein in the edible portion of the fish is made up of three types of protein: (1) Sarcoplasmic or **water soluble protein**, (2) myofibrillar or **salt soluble protein** and (3) stroma or **insoluble protein** (connective tissue). In all cases, approximately 20% of the protein is sarcoplasmic protein and 75% is myofibrillar. Notice the relatively large amount of connective tissue in beef, as compared to fish. This accounts for some of the textural differences between the two.

In the surimi process, the myofibrillar or salt soluble protein is selectively extracted (Figure 5). After the fish has been headed, gutted and deboned the mince is washed liberally with fresh, clean water to remove water soluble proteins, various enzymes, blood and fat. It is necessary to wash away these constituents because many of them are related to the degradation of muscle during storage. Although 20 per cent of total protein is removed, this process is necessary to achieve the desired texture and storage properties of surimi. Small particles of skin, bone and connective tissue are removed using a refiner, while excess water is removed using a screw press. The material which exits the screw press is a relatively wet (80% water) fish mince which is primarily myofibrillar protein.

As depicted in Figure 6, surimi is made up of long myofibrillar proteins which form a disordered sol when chopped with salt.

When permitted to stand at a relatively low temperature the sol forms a more ordered structure. This phenomenon is known as suwari in Japanese technology. When heated, this surimi structure forms a very ordered, elastic gel which we find in kamaboko. The degree of order which is related to the gel strength depends on the condition of the protein.

When trying to control the surimi process, one is actually attempting

to optimize the association between proteins to produce a functional gel.

Proteins from warm blooded animals must be handled with a certain degree of care; they perform their functions optimally under rigid conditions of temperature, pH, ionic strength, etc. Proteins from cold water fish are probably more difficult to handle than the average protein from warm blooded organisms. Because fish are cold water adapted, so are their constituent proteins. This means that handling fish at temperatures much higher than their habitat temperature will produce the effect of the protein behaving less than optimally. The usual reason for this is that the protein "denatures" (Figure 7).

Denaturation is actually a change of form of the protein and depending on the extent of abuse, may be reversible or non-reversible. A partially denatured protein may be partially functional. We suspect that, as fish is aged on ice, it goes through partial denaturation; we are not sure if the process is reversible. What seems to happen with surimi processing is that to achieve a highly ordered gel (high ashi), myofibrillar proteins must be in their native or natural state. If protein has been partially denatured, it must be processed under conditions which promote optimal results. The maintenance of conditions which produce these results are the controls for the surimi process.

Factors Affecting Surimi Production

Because we are dealing with a protein system when processing surimi, it is important that a low temperature be maintained. The rule of thumb for the industry is 10°C although this figure has been derived from Japanese experience where water temperatures are higher. Cold adapted proteins from our fish probably have a lower temperature requirement.

Increases in temperature during production may result in a gel with lower strength.

Another factor which can easily be monitored and controlled is pH or acidity. Figure 8 shows the relationship between the pH of the wash water and the final gel strength of the kamaboko. As can be seen, for this starting material, there is an optimum pH, after which gel strength decreases rapidly. There is no guarantee that this pH is the same for all fish.

The pH also has an effect on expansion of the meat. As pH increases it becomes more difficult to dewater. Swelling may be controlled by another parameter known as ionic strength (Figure 9).

Ionic strength is actually a measure of the salt content of the water. The ions contained in fresh water include calcium, sodium, iron, phosphate, nitrate and a host of others. Generally, increasing the ionic strength to approximately 0.1 means the meat has an increasing tendency to dewater, after which it binds water much more tightly. Again an increased affinity for water will decrease the gel strength of the kamaboko. As shown in Figure 10, the ultimate gel strength of surimi is also affected by the hardness of the water. As hardness increases so does the gel strength. Water content decreases with water hardness; this has the same effect as increasing ionic strength. Hardness of water is determined by the calcium and magnesium content. By increasing the calcium or magnesium concentration, you also increase the ionic strength and hence lower the water holding capacity.

The pH, hardness and ionic strength are all controllable parameters. The two main sites for controlling the process will be the primary leaching tank and the saline tank (Figure 11).

Before proceeding with a discussion of the mechanical aspects of process control, Figure 12 gives a summary of the considerations which have been presented thus far.

Figure 12

(1) Lean fish contain 20% protein 80% water in the edible portion;

(2) surimi is made from salt soluble portion of the protein, Myofibrillar protein;

(3) the functionality of surimi lost if myofibrillar protein is denatured;

(4) process must be controlled to stop denaturation;

(5) temperature, pH, water hardness and ionic strength represent controllable parameters.

Surimi Processing Technology

Manufacturing surimi, brewing beer, and making cheese are all traditional food processing arts that were developed long before the microbiology or biochemistry of the process was understood. Surimi, beer or cheese can be prepared using a recipe. The results will be consistent as long as the ingredients are uniform and consistent. Variation in the quality of ingredients may result in a poor quality product or complete failure of the process. Without understanding the process itself the manufacturer has no reliable method other than trial and error to accommodate ingredients of variable quality. Further, the manufacturer has no method other than trial and error to find ways to speed up a process, to improve yield to improve quality.

Traditional surimi manufacturing equipment and know-how have been developed and optimized for a single ingredient: fresh Alaskan pollock fillets. The manufacturers of surimi processing equipment will warn a processor that even minor deviations from prescribed procedure or use of old pollock may result in failure of the process.

On the other hand, a food scientist working in the laboratory may claim that good quality surimi can be made from almost anything that moves. The difference is that the scientist does not rely on a fixed procedure and can accommodate variations in input materials (Figure 13).

The dairy and brewing industries made a transition from processing by recipe through knowledgeable manipulation of microbiology early in the century. This has allowed:

a) increased quality and throughput
b) reduction in processing time and energy
c) reduction in processing cost due to substitution of lower cost additives, etc., and
d) predictable product quality with variable feedstock materials.

he surimi industry is on the threshold of similar changes that are being dictated by growing market demand and shrinking resources.

Can surimi be made from underutilized species, from cod frames? Will the quality be acceptable? Is suitable equipment available? Can wash water requirements be reduced? Can the same equipment handle two different species? Can the same piece of equipment handle fresh and sour fish? Can equipment be scaled up or down in size to match throughput from a specific plant or processing line?

The answers to all questions are yes - in principle. There are no barriers, with the following provisions:

- minimize time/temperature exposure of raw materials and mince.
- do not expose to **denaturing conditions** including excessive ionic strength, harsh solvent and chemicals, high temperature, undue mechanical shear (e.g., blendor).

Optimizing Processing Machinery

Existing surimi equipment has been engineered for high volume uniform production. The economies of large-scale production are not necessarily optimal for Atlantic Canada surimi production.

In many industries today, manufacturing practice is moving away from high-volume,low cost toward flexible production at intermediate volumes as result of programmable robotic machinery.

The modern surimi industry was originally developed around an annual harvest of 2 million tonnes of fresh Alaskan pollock fillets at 5 cents/pound. Plants in Alaska have been built to handle large volumes of uniformly sized fresh fish.

Newfoundland and other areas are likely to manufacture surimi from species available in one hundred thousand tonne annual volumes, volumes not necessarily available fresh because of seasonal harvesting patterns and geographically dispersed landing sites. Equipment must be scaled to typical plant throughput, versatile enough to handle different materials at different seasons. At the same time, it must not require Ph.D biochemists to operate it.

CANPOLAR has been developing process control systems that can be used to make surimi process machinery versatile, provide consistent product quality, while not requiring highly trained operators.

Much of what we are doing is applying well-known chemical engineering practices to the surimi manufacturing process.

Leaching and Washing Operations

The conventional Bibun or Yanagiya washing system is a batch washer consisting of an agitated holding tank that can be filled and emptied intermittently or continuously (Figure 14). Depending on the starting material, longer or shorter washing times or increased numbers of wash cycles are used. Frame mince for example, may require increased washing cycles to achieve a desired white color.

Batch operation is not as efficient as continuous processing. The equipment shown can be operated in a continuous feed mode, but for this equipment layout, continuous feed results in irregular exposure of particles.

Alfa-Laval has introduced an improved continuous wash system (Figure 15) which has the advantage of controlled, constant, leaching exposure. This system is installed and is operating successfully in the Alaska Pacific Seafoods plant in Kodiak.

The most efficient leaching systems in use for food processing and chemical extraction are countercurrent extractors which have minimum water solvent consumption and provide excellent control opportunities (Figure 16). CANPOLAR is currently working on the development of a countercurrent mince washer that is efficient, takes up very little floor space and is mechanically simple.

Dewatering

The conventional method for dewatering surimi employs the screw press which is actually an auger-type conveyor inside a perforated barrel screen (Figure 17). As the meat is conveyed a pressure is built up and water is extruded through the screen. Although the screw press works on a continuous basis, it has several drawbacks for processing surimi:

1. Because pressures built up by the press are very small, processing is slow; residence times inside the screw press for the surimi pilot line are approximately 30 minutes; larger presses may take more than an hour. Figure 18 shows a typical temperature profile of the surimi process from a pilot scale production. Approximately one-half the processing time involved dewatering; the temperature in the screw press was greater than 10°C.

2. Long processing times generally lead to rises in temperature and protein denaturation.

3. The screw press is difficult to adjust or control during processing; incorporation of sensor controlled processing would be impractical.

Again, Alfa-Laval has recently made considerable improvements in the dewatering process with the introduction of a twin-screw press system. The twin screw has the advantage of producing higher pressures for faster dewatering. This reduces product hold-up time substantially.

In Summary

(1) Surimi production is an industrial extraction of myofibrillar protein.

(2) Conditions can be optimized to produce consistent product from variable input materials.

(3) Equipment with the required control options can be simple and economical.

AN OLD SURIMI AND KAMABOKO MAKING PROCESS. Reproduced by courtesy of Suzuhiro Kamoboko Kogyo co., Ltd. Odawara, Japan. 1-fish harvest; 2-gutting and cleaning; 3-filleting; 4-mincing; 5-washing; 6-dewatering; 7-chopping; 8-stone grinding with salt and spices; 9-straining; 10-shaping of kamaboko; and 11-steaming of kamaboko. FROM LEE (1984)

FIGURE 1

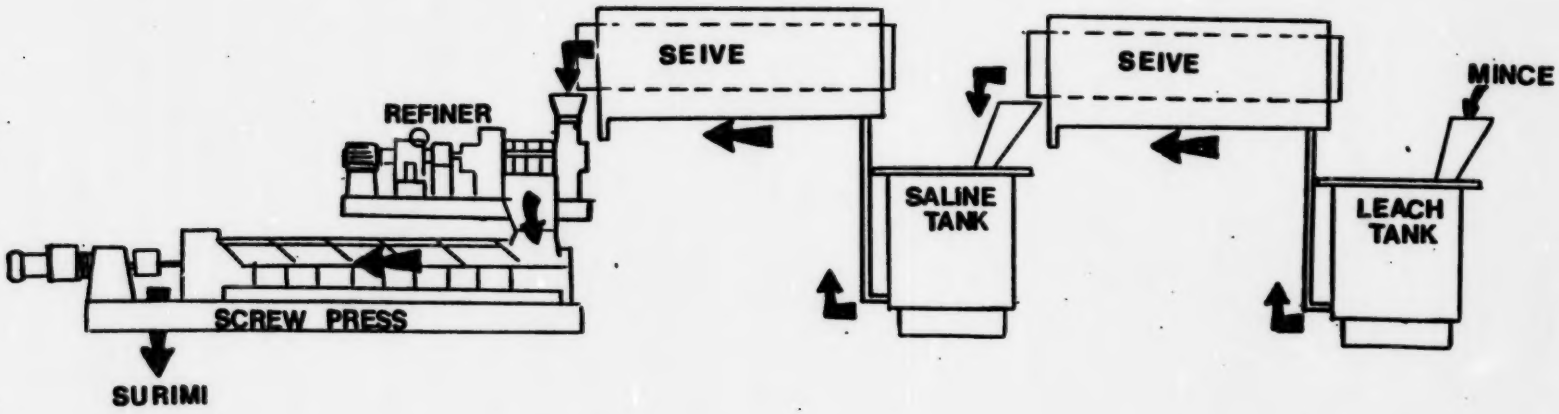
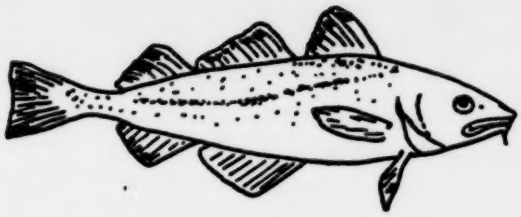


FIGURE 2-MODERN SURIMI PROCESSING



PROCESSING (fillet. mince)

GUT
SKIN
BONE
HEAD

EDIBLE PORTION

~80% WATER
~20% PROTEIN ★

SURIMI

~76 % WATER
~16 % PROTEIN ★
~ 8 % OTHER

FIGURE 3
PROTEIN PROCESSING

Flesh source	Sarcoplasmic	Myofibrillar	Stroma
fish, normal range	10–20	70–90	3–10
cod	21	76	3
carp	24	71	5
flounder	21	76	3
beef	16–28	39–68	16–28

Elasmobranchs may contain upt to 10% stroma protein. (Suzuki.1981.Fish & Protein, Applied Sci.).

FIGURE 4
PROTEIN COMPOSITION

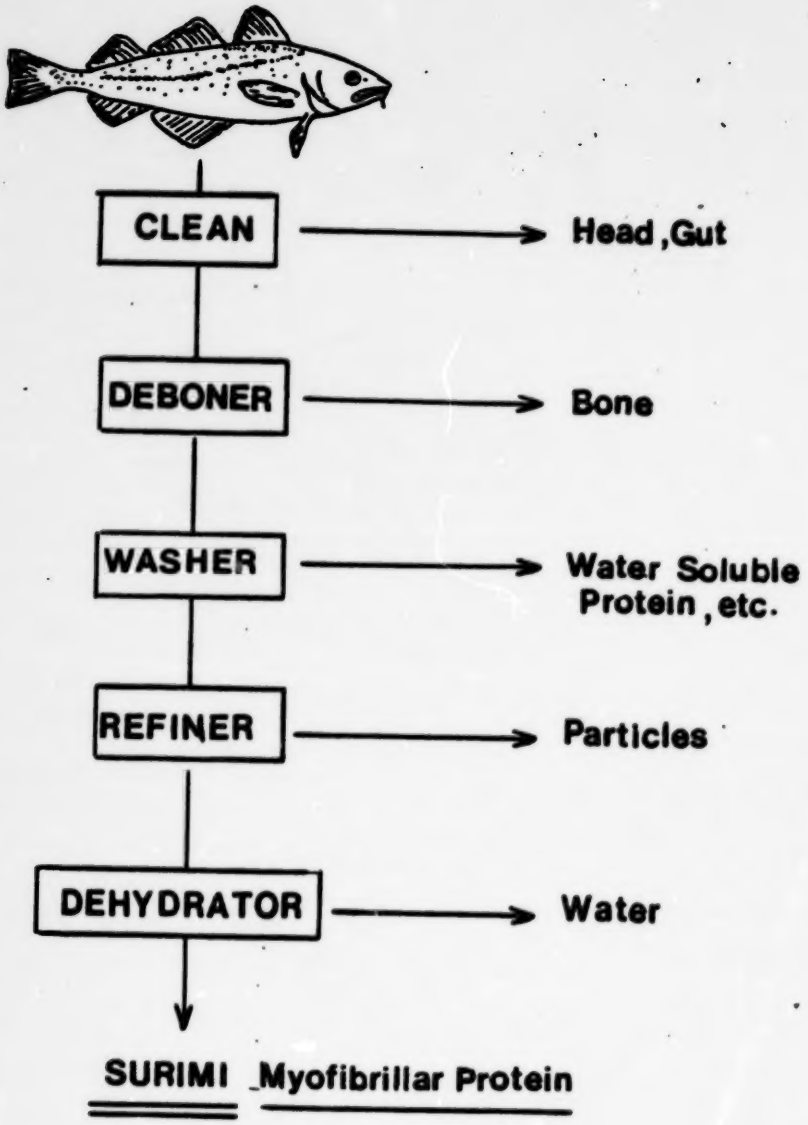


FIGURE 5
SURIMI
MYOFIBRILLAR PROTEIN

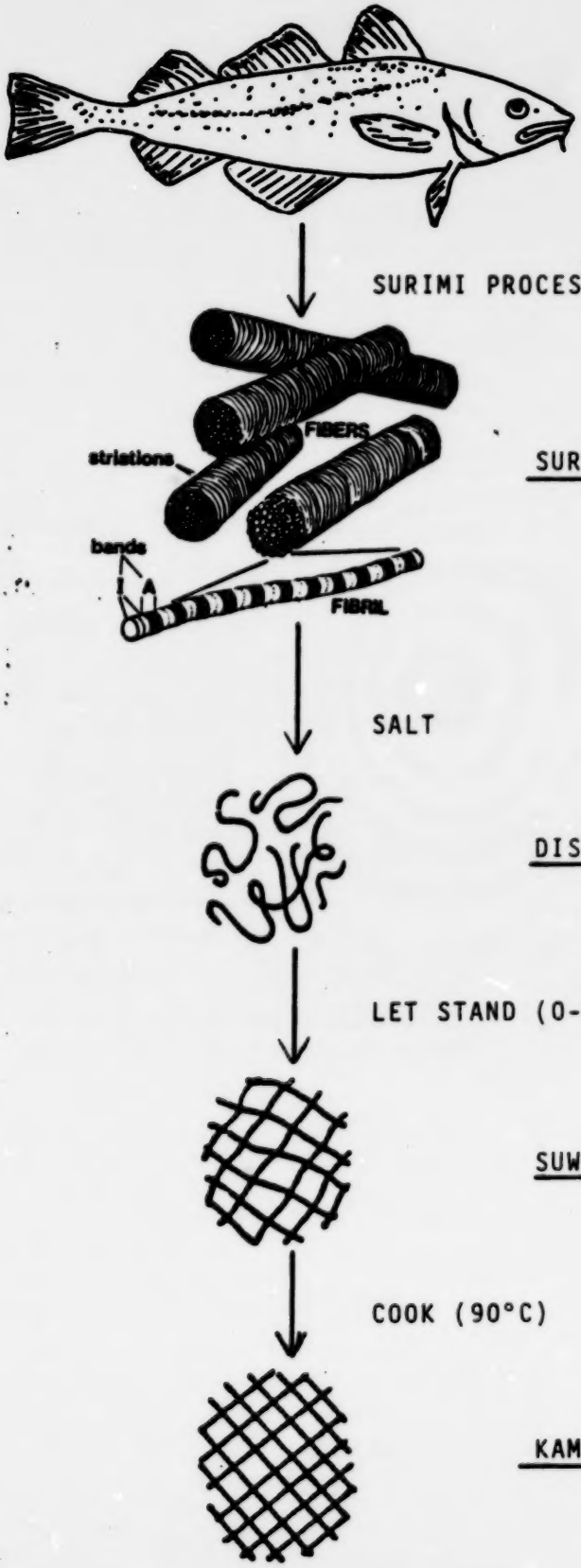


FIGURE 6
PROTEIN GELS

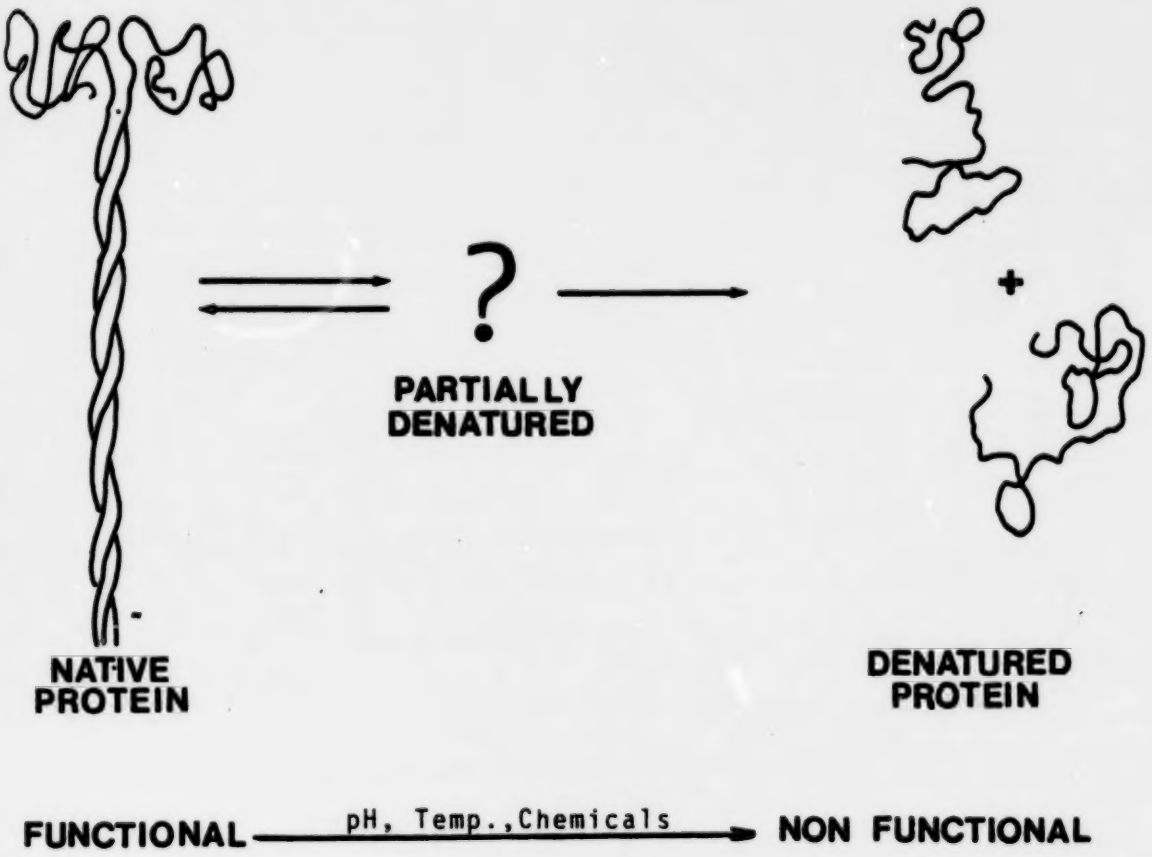


FIGURE 7
PROTEIN DENATURATION

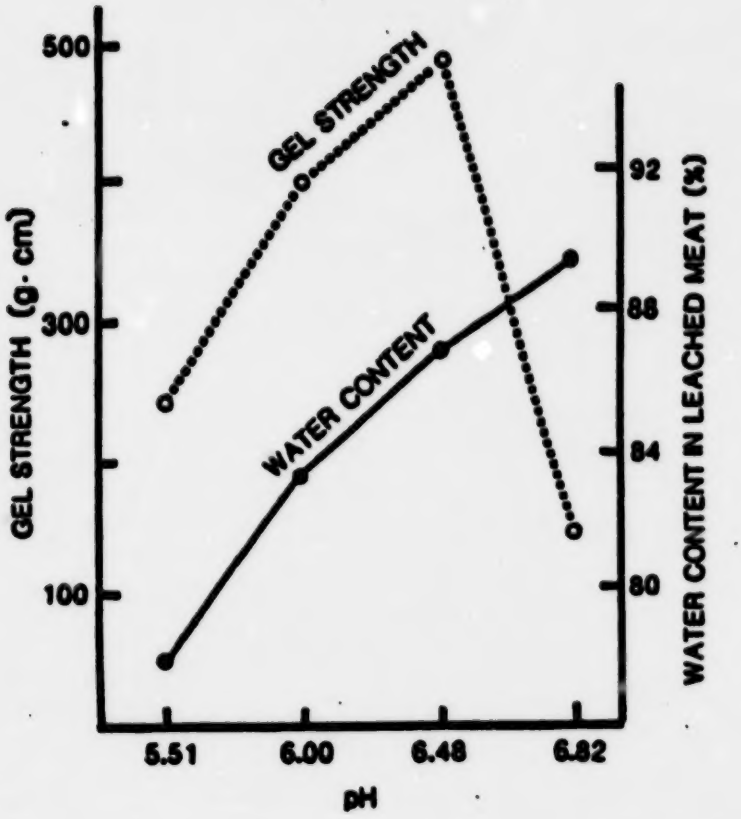


FIGURE 8 EFFECTS OF pH OF LEACHING WATER ON SWELLING OF LEACHED MEAT AND GEL STRENGTH OF SURIMI

3

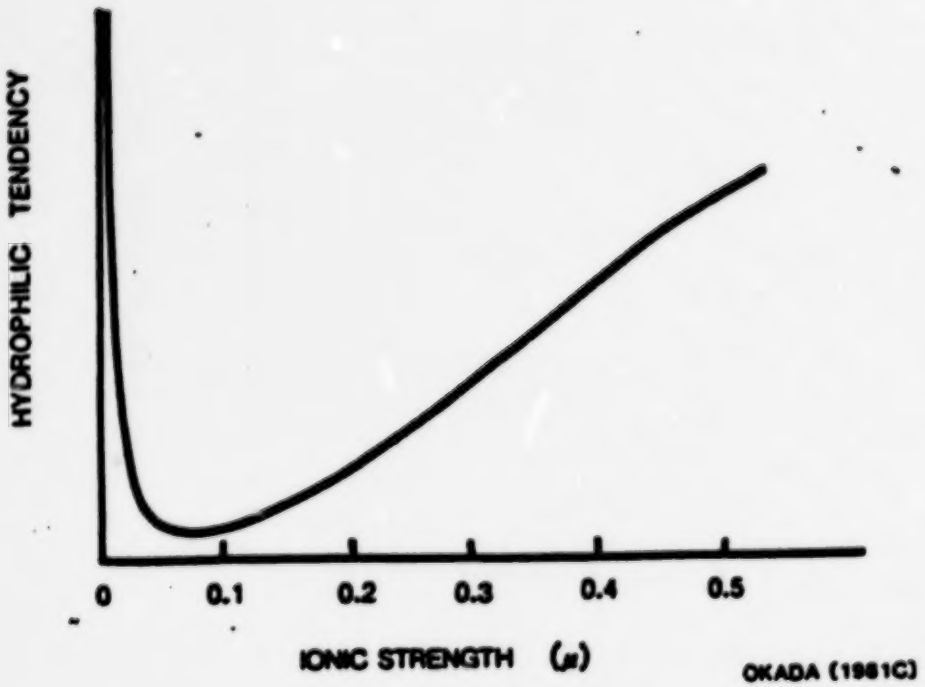


FIGURE 9 HYDROPHILIC TENDENCY VERSUS IONIC STRENGTH OF MYOFIBRILLAR PROTEIN

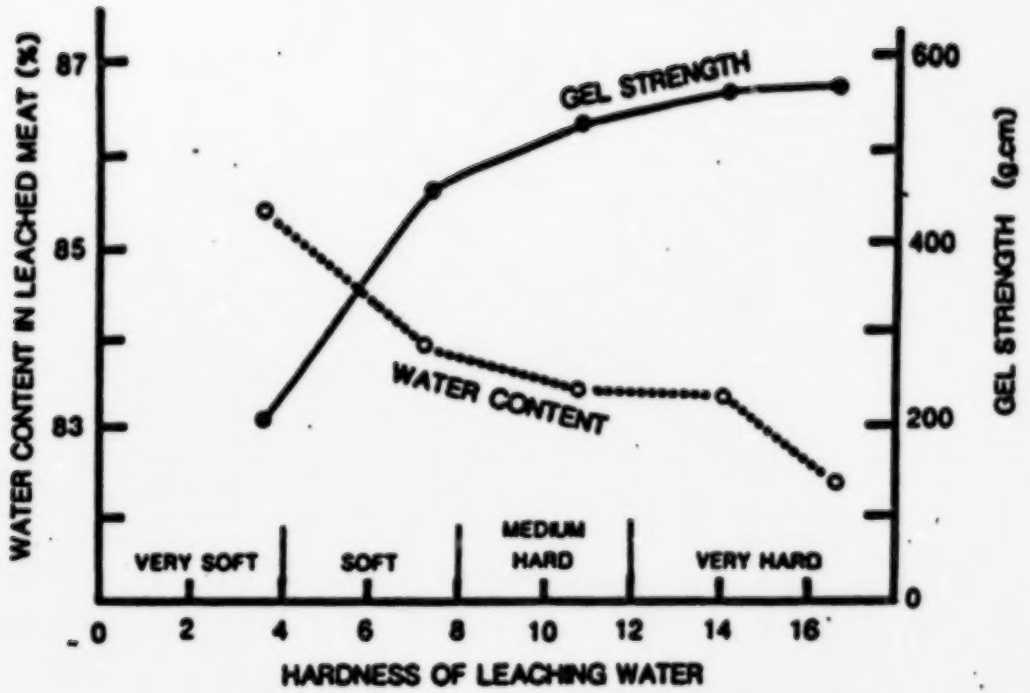


FIGURE 10 **EFFECTS OF HARDNESS OF LEACHING WATER ON SWELLING OF LEACHED MEAT AND GEL STRENGTH OF SURIMI**

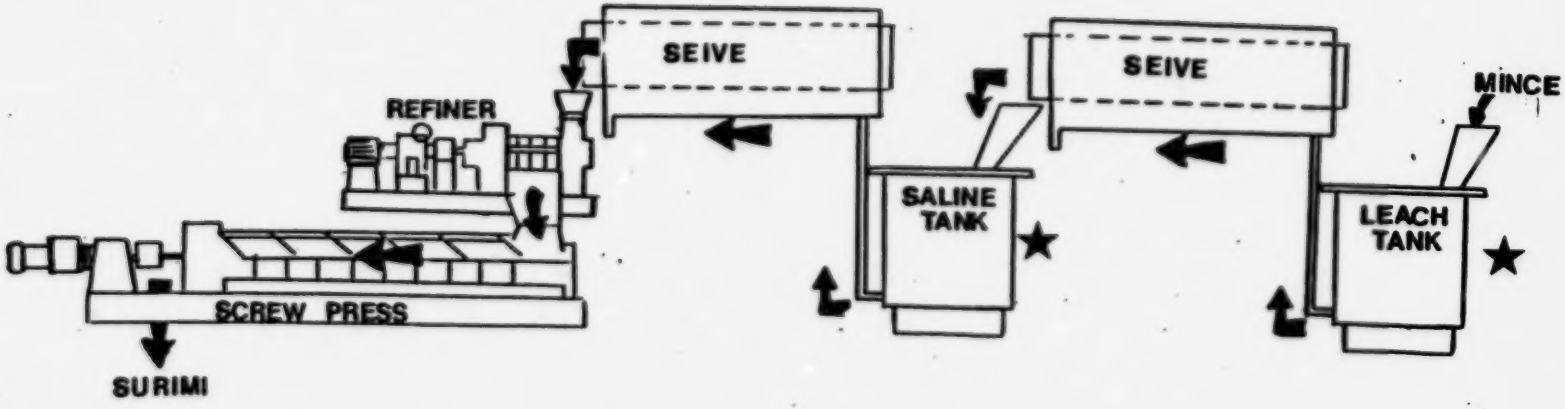


FIGURE 11 – CONTROL SITES FOR pH, TEMPERATURE, IONIC STRENGTH AND HARDNESS

PROCESSING CONDITIONS		
SPECIES	VARIATION	MODIFICATION
POLLOCK FILLETS	NORMAL	NORMAL
DOGFISH SHARK	-DARK FLESH -PRESENCE OF UREA -OFF ODORS	-INCREASE LEACH TIME AND VOLUME TO ELIMINATE ODOR -INCREASED WASHING MAY INDUCE SWELLING -ADJUST IONIC STRENGTH OR USE DIVALENT CATIONS TO FACILITATE DEWATERING
HERRING	-DARK FLESH -HOGH FAT CONTENT	-INCREASE LEACH TIME AND/OR VOLUME -ADDITION OF MATERIAL TO PROMOTE FAT INSOLUBLIZATION
WARM WATER SPECIES	-PROTEIN ADAPTED TO WARM TEMP. -MAY BE DIFFICULT TO DEWATER AT LOW TEMPERATURE	-RAISE PROCESSING TEMPERATURE
SOUR COD FRAMES	-LOW QUALITY -OFF COLOR AND ODOR -SURFACE CONTAM-INATION -BLOOD -LOW pH -PARTIAL PROTEIN DENATURATION	-INCREASE WASH CYCLES -ADJUST pH -FACILITATE DEWATERING BY ADJUSTING IONIC STRENGTH
		CANPOLAR

FIGURE 13 - PROCESSING CONDITIONS

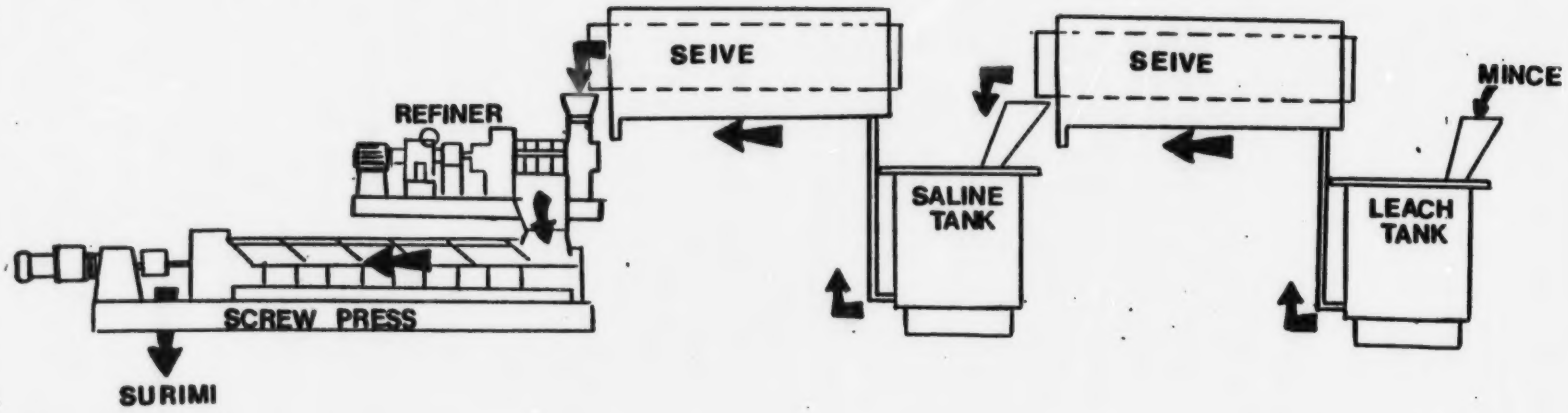


FIGURE 14-CONVENTIONAL SURIMI PROCESSING

Alfa-Laval decanter-based Surimi production

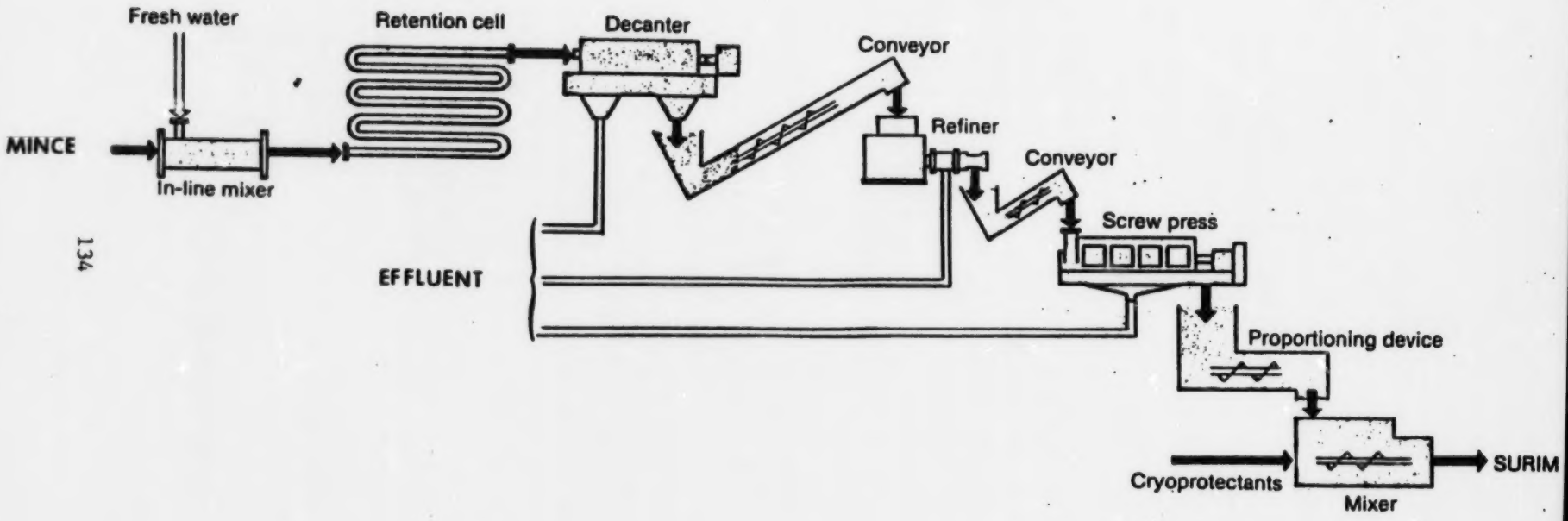


FIGURE 15

ALFA LAVAL SURIMI PROCESS

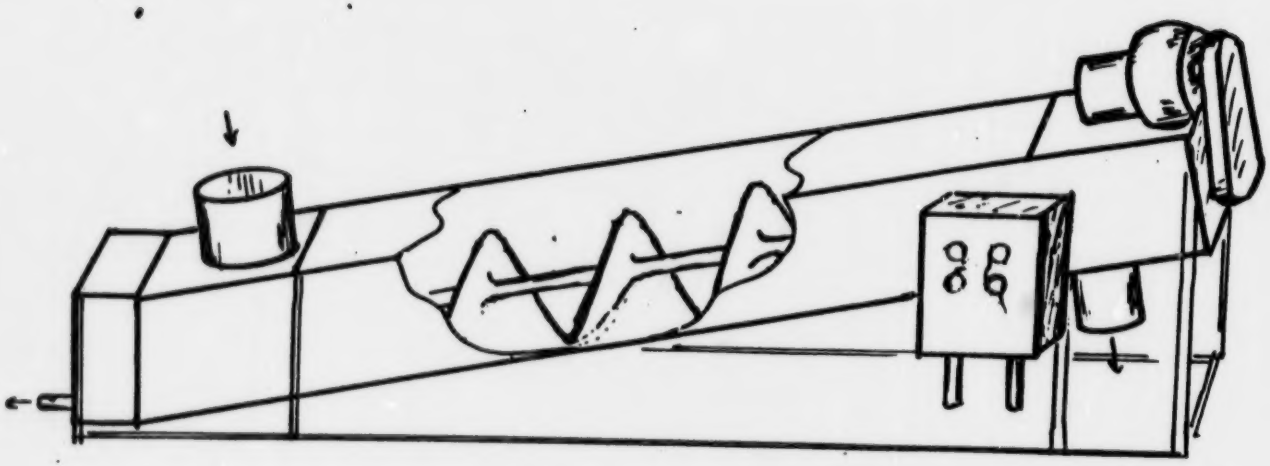


FIGURE 16 - COUNTERCURRENT WASHER

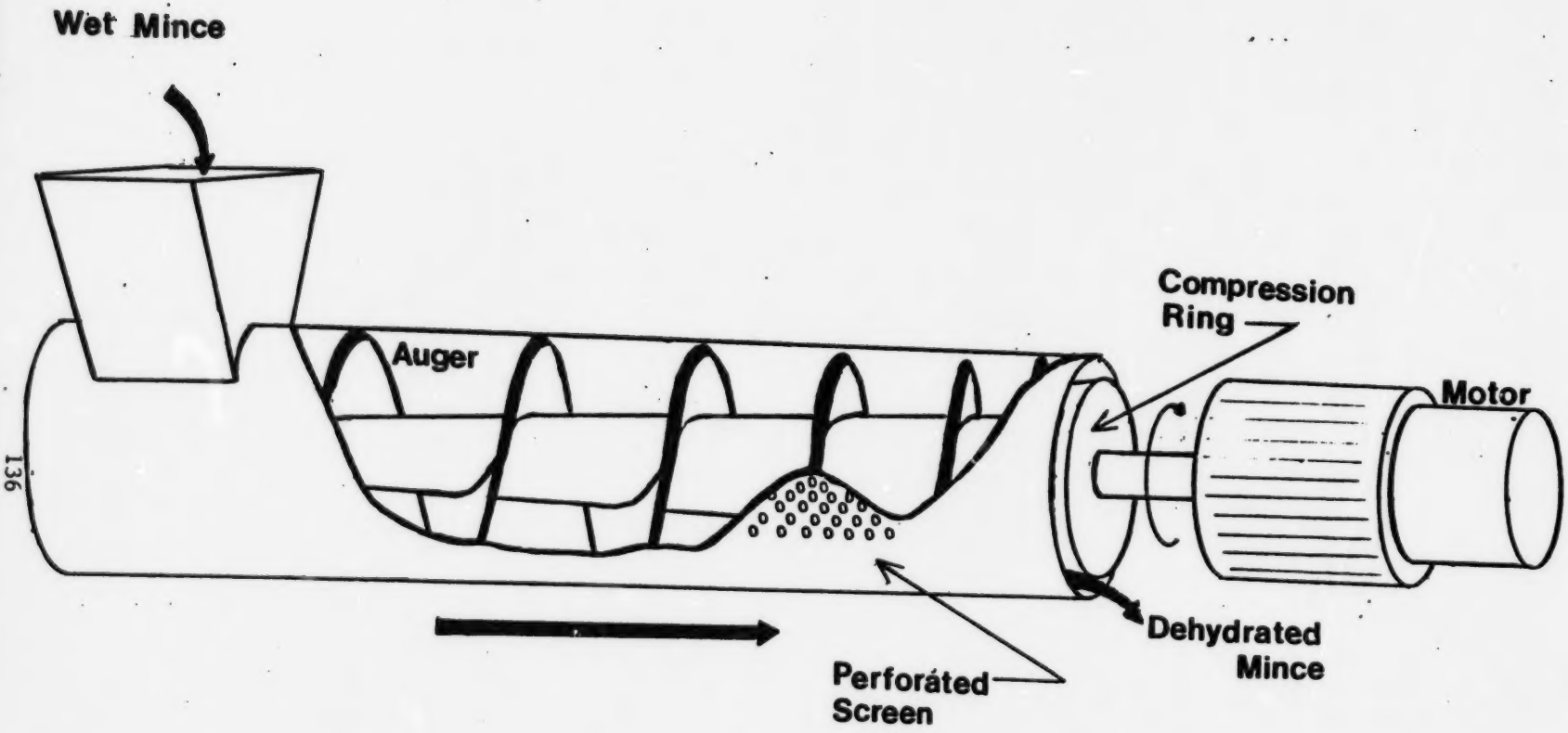
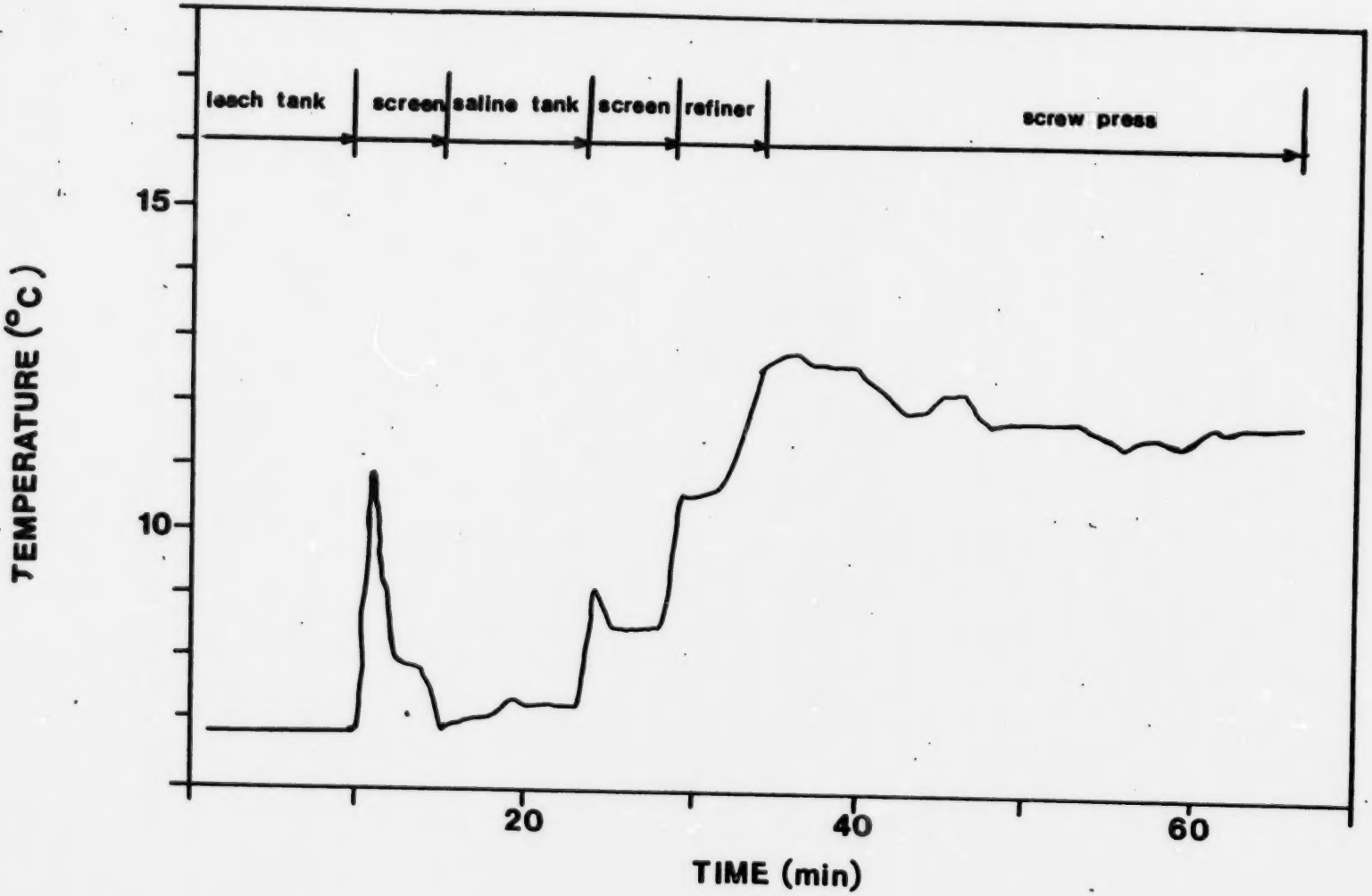


FIGURE 17
CUTAWAY OF CONVENTIONAL SCREW PRESS

FIGURE 18

TEMPERATURE PROFILE
BIBUN PILOT LINE



Flavour Development for Seafood Products

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Introduction

These studies were undertaken as a result of increased demand from the surimi industry for the formulation of crustacean flavourants for kamaboko products. More than 100 million pounds of these products were produced in 1985. Their formulation usually incorporates up to 2% of crustacean flavourants into the kamaboko process. An additional ten-fold growth in American consumption of surimi-based products is predicted by the early 1990's. Other products, such as soups, sauces, bisques, dips and leached-shellfish meats also provide a market for shellfish flavourants.

More than two-thirds of all shellfish harvested is processed. The meat yield from shellfish is relatively low (about 16 to 30%). As a result, large quantities of offal are produced. In Atlantic Canada, offal from shellfish processing is not utilized, thus causing environmental and disposal problems. These wastes contain significant amounts of compounds responsible for the flavour of the corresponding species.

Commercially available shellfish flavourants originate from Japanese and European sources. They are composed of either synthetic mixtures and/or mixtures of natural extracts, amino acids, nucleotides, plant/meat/yeast hydrolysates, volatile essences, higher alcohols/esters/aldehydes and flavour modifiers. Costs for the

flavourants are substantial and have been subject to dramatic price escalations (about 40% in 1986).

Crustacean processing wastes consist of cooker liquor, bodies, heads, shells, legs, expressed juice, rinse water, viscera, roe and meat-separator by-products. The proximate composition of the solids in crab offal is as follows: crude protein - 28% (contains free amino acids and nucleotides); crude lipid - 14%; minerals - 36%; chitin - 21% and other solids - 1%. The primary purpose of the latest research has been to develop the data-bases and technology necessary to establish industrial processes for the preparation of natural crustacean flavourants from raw materials available in Canada. The secondary objective has been to develop the technology to utilize extracts in the formulation of finished products, such as crab-flavoured kamaboko. The development of the knowledge and the processes to recover the flavour essences from shellfish offal will provide an economically stable supply of flavourants for the Canadian food industry, and will also enhance the existing shellfish industries by providing revenue from by-product utilization.

The funding for these studies was provided by the Department of Fisheries and Oceans, National Research Council, Newfoundland Department of Fisheries and by private sector companies. Since regional and private sector monies were employed, certain information generated through these studies is of a proprietary nature.

Methodology

Detailed protocols for the methodology employed are provided in the final contract reports listed in the reference section of this presentation. Crustacean processing wastes and meats have been extracted using, respectively, hot water or ethanol for sensory or

analytical evaluation. The extraction procedures for the taste-active components have employed the methods developed by Konosa and Hayashi. Flow charts outlining the protocols used for the extraction of taste-active substances in shells, broth and meat are illustrated in Fig. 1, while the protocol for the quantification of betaine is outlined in Fig. 2. Broths have been concentrated by using a Paterson Candy Reverse-Osmosis Pilot Plant (from 2-3 degrees to 15-17 degrees Brix) prior to spray drying. A Cherry-Burrel Votator Turba-film Evaporator has also been used to concentrate broths (from 2-3 degrees to 50 degrees Brix). Figure 3 outlines the unit operations used for concentrating crab broths by reverse-osmosis and also by flash-evaporation. Volatile flavour entrapping agents (malt dextrins) have been added to the concentrates prior to spray drying. Extraction aids, such as enzymes, antioxidants and acidulants, have not been employed to determine their influence on yield and sensory quality of the flavour concentrates. The sensory characteristics of broths and flavoured/texturized kamaboko have been evaluated by untrained/informal taste panels at Memorial University and Griffith Laboratories.

The basal concentrations of primary taste-active components in the surimi and in the flavour concentrations has been used to develop formulations for preparing crustacean flavoured kamabokos. Target concentrations for the components that comprise the formulations have been initially set at the amounts found in natural concentrations and adjusted to reflect the responses obtained from the sensory evaluations. The formulations for the texturized kamabokos have included the incorporation of stabilizer systems that have been developed through cooperative studies undertaken with Terra Nova Fishery Co. Ltd. and Canada Packers Inc.

Laboratory-scale quantities of imitation scallop are being prepared from cod surimi using an extrusion device that was designed and fabricated at Memorial University. A contact for fabricating a

prototype of a commercial-scale extruder has been submitted for funding. The imitation scallop formulation employs ingredients that are of Canadian origin. The current scallop flavourant uses adductor muscle as a raw material. Studies have been undertaken to determine the suitability of scallop mantle and viscera as a flavourant source.

A breading/battering system for the imitation scallop has been developed. The current product is reconstituted by heating from the frozen state in a radiant oven.

Results and Discussion

Cooker water obtained from commercial crab processing lines has been identified as the initial source of raw material for producing a natural crab flavourant. The rate of accumulation of solids (soluble and insoluble) in cooker water obtained from a continuous crab processing unit was measured. The rate of accumulation of solids decreased markedly after 2 hours. This indicates that cooker water can be withdrawn continuously after 2 hours and then either cooled and stored or fed directly into a flash-evaporation process system. Feeding the hot broth directly to a flash evaporation system has the advantage of utilizing the heat carried with the hot liquor for partially providing the energy required for vaporization in the vacuum evaporator. The potential rate for withdrawing the broth from the cooker tank has not been determined. Another option that is being considered is the transfer of bulk quantities of broth from the cooker unit (after cooling and clarification - at intervals greater than 2 hours) to a storage tank. This approach permits all of the broth to be concentrated after a critical volume has been accumulated. Disadvantages of the batch approach is the greater opportunity for thermal damage, the high energy requirements for cooling and reheating and also the need for substantial cold storage tanks. Theoretically,

the concentrate produced from the reverse-osmosis system would contain higher concentrations of aromatics than the product produced by flash evaporation. Currently, this laboratory has not established means for objectively measuring the concentrations of aromatic components of importance to crustacean flavour. However, sensory evaluation of the concentrates indicates that the product from the flash evaporator is characteristic of cooked shellfish.

The contents of selected taste-active components and solids in samples obtained from crustacean wastes, and also from commercially available shellfish flavourants, are listed in the final reports cited in the reference section of this manuscript. The contract reports also detail the results of process development, sensory evaluations, product formulations and equipment development.

Future Studies

The scope of future efforts to be undertaken as part of this project includes the following: 1) The establishment of data-bases that detail the content of aromatic components present in crustaceans and crustacean by-products; 2) The optimization of the reverse-osmosis and flash-evaporation processes for concentrating crustacean flavourant broths; 3) The addition of a volatile essence recovery system to the flash evaporator; 4) Determination of the cost effectiveness of reverse-osmosis, flash evaporation and other types of evaporation technologies; 5) Evaluation of the effect that the employment of extraction aids has on the yields and sensory profiles of crustacean extracts; 6) The expansion and optimization of flavour-based and product-formulation technologies; and 7) The transfer of crustacean flavourants to industry for commercialization.

Acknowledgements

Appreciation is expressed to V. Ervin, B. Higdon, M. Howley, M. Keats and P. Mansfield for technical assistance. The free-amino acid analyses were completed by D. Hall and S. Banfield. The inorganic ions were determined with the assistance of V. Whalen and M. Mackey. The analyses for nucleotides were completed at Griffith Laboratories, through the cooperation of Drs. J. Holme and F. Comer. Dr. C. Ho of Terra Nova Fisheries provided surimi for the preparation of kamaboko. Ouinlan Brothers Ltd., P. Janes and Sons Ltd., United Maritime Fisheries and Fishery Products International provided access to their crustacean processing lines allowing us to obtain samples for analyses. The Department of Fisheries and Oceans in St. John's provided live scallops.

Figure 1. Protocol used to extract taste-active substances from shells, broth and meat.

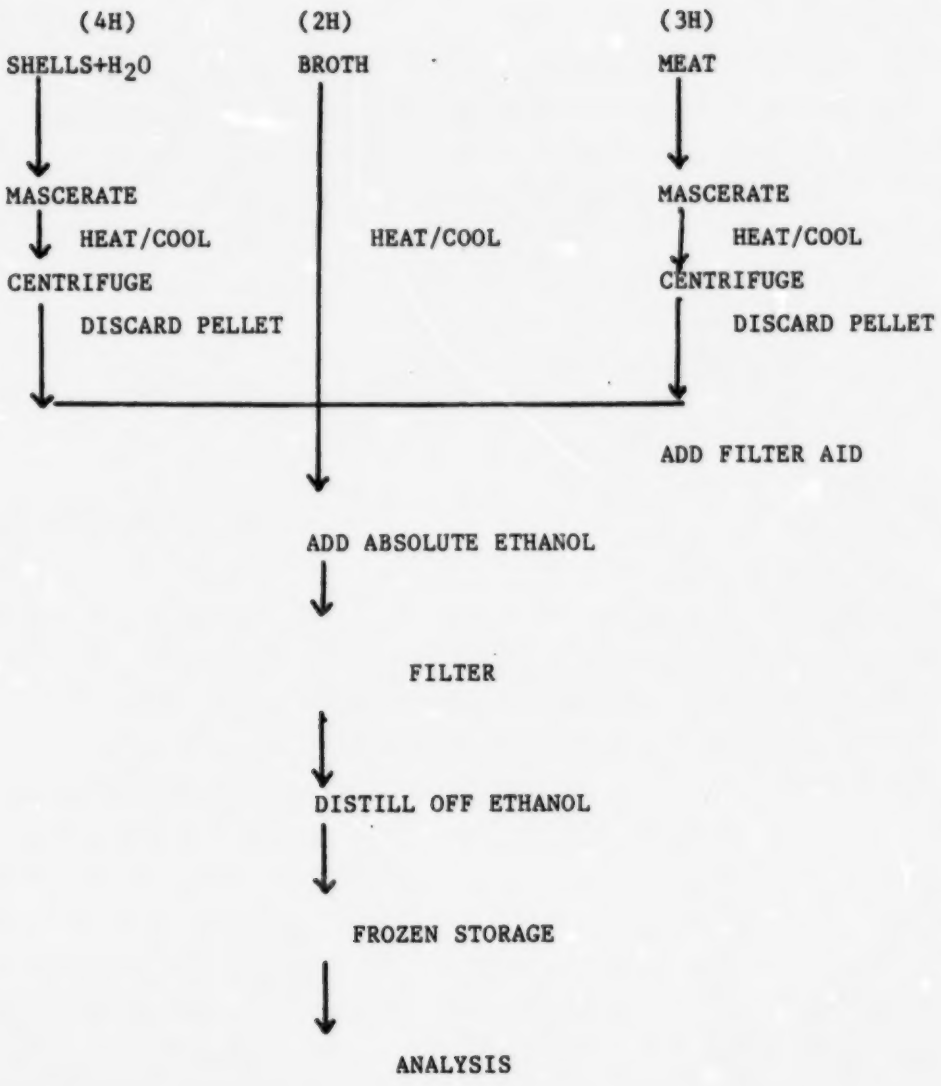


Figure 2. Protocol used for the quantitation of betaine (requires 5 days).

1. SEPARATION BY ION EXCHANGE CHROMATOGRAPHY

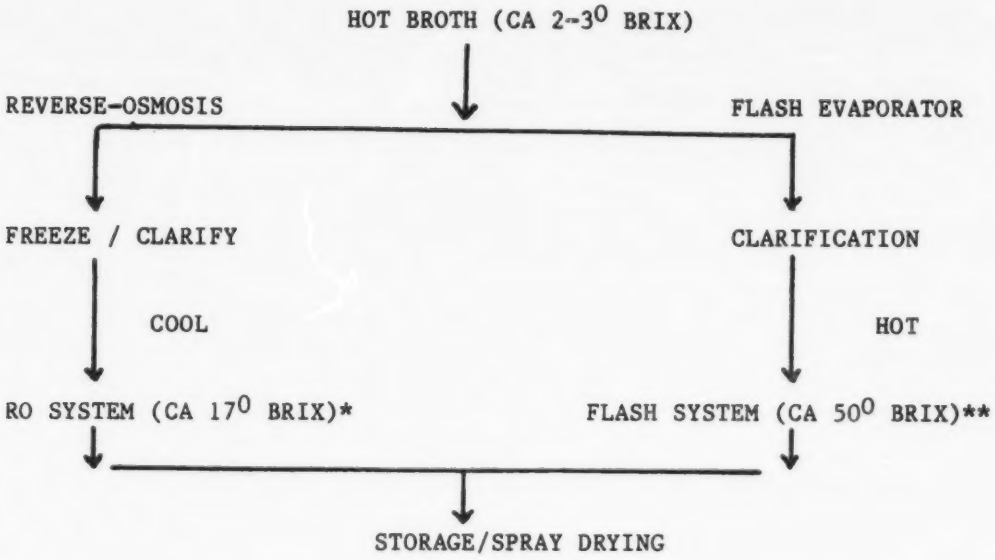
   A. FOUR ION EXCHANGE COLUMS: WEAK ANION
      WEAK CATION
      STRONG CATION (FRACTION COLLECTOR)
      WEAK ANION

   B. OVERNIGHT DRYINGS (IN VACUO) BETWEEN EACH COLUMN

2. QUANTITATION

   A. PREPARE REINECKATE DERIVATIVE.
   B. WASH CRYSTALS WITH ETHER.
   C. DISSOLVE CRYSTALS IN ACETONE, READ A_{525}. EXTRAPOLATE AGAINST STANDARD CURVE.

Figure 3. Unit operations used for concentrating crab broths by reverse-osmosis and also by flash evaporation.



* FLOW RATE IS DEPENDENT ON THE OPERATING TEMPERATURE, BACK PRESSURE AND SURFACE AREA.

** FLOW RATE IS DEPENDENT ON THE TEMPERATURE OF THE BROTH AND OF THE HEAT EXCHANGE JACKET, DEGREE OF VACUUM AND SURFACE AREA OF THE HEAT EXCHANGER.

References

1. VOIGT, M.N. 1986. A STUDY OF THE USE OF COD, COD BY-PRODUCTS AND CRUSTACEAN BY-PRODUCTS FOR SURIMI AND SURIMI-BASED PRODUCTS. PART III. SHELLFISH FLAVOUR EXTRACTION STUDIES. LABORATORY STUDIES ASSESSING THE SUITABILITY OF CRAB PROCESSING OFFAL AS A SOURCE OF FLAVOURANTS. CAN. REP. FISH. AQUAT. SCI. 1492: VII+42P. (MINISTER OF SUPPLIES AND SERVICES CAT. NO. FS 97-14/1492E ISSN 0704-3694).

2. FINAL REPORT FOR 1986-87 DFO/DSS/PROVINCIAL CONTRACT. REPORT IS TO BE SUBMITTED IN APRIL 1987.

3. INFORMATION FROM THE NRC CONTRACTS MAY BE MADE AVAILABLE IF THE PERMISSION OF THE PROPONENT COMPANY IS OBTAINED.

2ND QUESTION PERIOD

Discussion during the second question period centered on four areas of interest to delegates:

- Age of raw material (post mortem)
- Surimi-based meat products
- The two stage production process, and
- Grading

1. Age of Raw Material: Interest was expressed in the feasibility of using raw material (herring) more than two days after harvesting. But work described in the Ablett presentation involved only the freshest raw material. Age does affect pH; levels lower than 6 debase the protein. TUNS work on herring indicates that best results were achieved at a pH level of 6.1 to 6.2.

2. Surimi-based Meat Products: Surimi-based pork and chicken products, so far, have not encountered a lack of acceptance on the part of the consumer. While there have been no formal studies, indications are that proper labelling does not pose an acceptance problem. However, it was noted that jurisdiction over inspection responsibilities of land-sea products may prove problematic for the government agencies involved.

3. The two-stage production process: It was observed that there seemed to be no shortage of information about surimi itself — stage one of the production process. However, the situation is quite different at stage two (surimi-based products). Confidentiality would seem to be the norm at the product development stage of the process, and it is anticipated that this trend will continue — for commercial reasons.

4. Grading: There was concern about the ramifications of grading surimi (SA Grade and Grade 2 Surimi). It was noted that grading has normally been conducted on the basis of gel strength, the end-use determining the gel strength most appropriate for each application. Processors feel that the quality emphasis should be replaced by an "end-use" emphasis in the grading process.

Regulatory Requirements for the Manufacture of Surimi and Surimi-based Products

by

Robert Mills

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Introduction

Canada and the United States have experienced exponential growth rates in the sales of surimi products. Initially, much of the product was imported from Japan; however, a domestic industry has emerged, manufacturing a variety of products which are competing with the Japanese. Beginning with initial imports of these products in 1981, food product regulators from both countries were concerned with the manner in which manufacturers were presenting their products. Labels were reviewed to ensure they were free from false and misleading statements or representations. Compositional formulae were also reviewed for accuracy and to ensure only the use of permitted additives.

Surimi-based products will continue to be a source of conflict between manufacturer and regulator; the former insisting on greater flexibility to promote and sell the fabricated fish product, the regulator trying to ensure fairness related to the name and use of descriptive terms for the product and to prevent the use of non-permitted additives. The very nature of producing products to simulate natural species or products using fish protein from another species will require greater co-operation to ensure the development of an informative labelling lexicon satisfactory to both manufacturer and consumer. The development and marketing of new products such as "sausage" type

products, the fabrication of processed meats using surimi, and the continued development of innovative products will add to the complexity of the labelling issues involving surimi-based products.

Raw Material Considerations

It has been reported that the manufacture of good quality surimi and, hence, the surimi-based products produced therefrom, is directly dependent upon the freshness of the raw material. Chong Lee reported[1] that the surimi-making qualities of fish decrease with a decrease in freshness. It has further been reported[2] that bleeding fish prior to surimi manufacture results in the production of a higher quality surimi than does the use of unbled fish. These factors must be considered if we are to continue developing high quality, surimi-based products which can compete with those produced in Japan.

The production of high quality surimi may also be undermined if producers seek out sources of low cost raw material without taking into account appropriate fish handling and preservation techniques. Salvaging of frame waste, "v-cuts" and other discarded trimmings from groundfish processing operations in Atlantic Canada appears to be a major untapped resource for surimi production. A need exists to ensure that the recovery and handling operations of by-products and wastes from groundfish processing operations are conducted in a clean and hygienic manner. Virtually all processing operations are now designed to remove such wastes, not currently used for minced fish, to offal pits or fish meal reduction plants. Processors will be required to convert processing lines to allow the sanitary collection of frame wastes without the fear of contamination from drains, floors, flumes, etc. Procedures for proper icing and handling will have to be strictly enforced to prevent the degradation of the raw material to protect its surimi-making properties, and to ensure that the raw material meets

minimum quality levels defined by the Fish Inspection Regulations[3], as well as product specifications. The Fish Inspection Regulations do not permit the processing of fish which is tainted, decomposed or unwholesome.

Development of Grade Standards and Specifications

The Japanese have readily recognized the importance of raw material in the manufacture of surimi-based products and have developed several grading systems to differentiate quality levels of the surimi used in their manufacture. The grading system is subjective in nature and is able to define the grade of surimi without defining its unique properties. The U.S. surimi industry has similarly attempted to define quality levels, but has taken a more objective approach in measuring individual properties of the surimi. Composition, including protein, fat, moisture, etc. and functional properties including surimi color, viscosity, gel formation strength, flavour and odour are important factors in establishing the quality of surimi. Efforts are now underway to standardize the different methodologies used to test surimi quality. The establishment of specifications based on objective measurement systems will also provide a mechanism for setting a market price based on the predicted characteristics of the finished product.

Canadian Regulatory Requirements

Processors and importers must be aware of the regulatory requirements which govern the production and sale of surimi and surimi-based products in Canada. The Inspection Services Branch of the Department of Fisheries and Oceans has the responsibility of enforcing the Fish Inspection Act and Regulations, applicable sections of the Food and Drug Act and Regulations, and the Consumer Packaging and Labelling Act

and Regulations. These regulations comprehensively govern the production and sale of domestic and imported products. The role of government inspectors in carrying out the enforcement of these regulations is to provide reasonable assurance that raw material used in the production of surimi is free from decomposition and taint and is handled in a sanitary manner to preclude its contamination; that processing facilities meet construction, equipment and operating requirements; that imported and domestic products are examined to meet standards respecting minimal quality, wholesomeness, safety, composition and weight; and that the product is correctly labelled.

Requirements under Canadian Food and Drug Regulations

The Food and Drug Regulations[4] permit the sale in Canada of any food which contains additives as prescribed under these regulations. Entry into Canada of surimi-based products, such as simulated crab legs, lobster tails and scallops, required appropriate amendments to legally allow these products to be sold. These amendments were made on July 25, 1984, and provided for the production of a prepared fish product, defined as a blend of prepared fish that has the appearance and taste of a marine or freshwater animal. Division B.21.006 was amended by the addition of a new section "n" which standardizes surimi-based products, with appropriate changes made to the tables in Division 16 to allow for the use of appropriate food colourings and other additives. Division B.21.006 has now been amended as follows:

> "Prepared fish or prepared meat shall be whole or comminuted food prepared from fresh or preserved fish or meat respectively, may be cooked or canned, and may,...(n), in the case of a blend of prepared fish and prepared meat that has the appearance and taste of a marine or freshwater animal, contain filler, fish binder, whole egg, egg white, egg yoke, food colour, gelling or

stabilizing agents, texture modifying agents, and natural and artificial flavouring preparations."

This amendment provides for the use of the following ingredients or additives:

- a filler, as defined in B.21.002 includes flour or meal prepared from grain or potatoes, processed wheat flour, bread or bakery products, etc., milk, whey powder, etc. and starch;
- a fish binder, as defined in B.21.007 for use in or upon prepared fish or prepared meat shall be filler with any combination of salt, sugar, dextrose, glucose, spices and other seasonings;
- whole egg, egg yolk or egg white;
- colour as provided for in Table III of Division 16;
- gelling or stabilizing agents, namely--sodium hexametaphospate, sodium pyrophosphate tetrabasic and sodium tripolyphosphate, at a level not to exceed 0.1% calculated as the named salt. The term sodium phosphate may be used to list the three agents;
- the texture modifying agent sorbitol at a level not to exceed 3.5%;
  and
- natural flavour or imitation flavour.

New technology may require the use of additives not named under B.21.006. Manufacturers are required to provide technological justification for use of any new additive and to apply for a change to the Food and Drug Regulations.

These regulations are deemed to be permissive rather than prohibitive. The fact that an additive is not listed as being permitted is usually because no one has asked that it be included or no technological justification for such an additive has been provided.

Labelling Requirements Under Fish Inspection Regulations

Because of a requirement to provide full disclosure on labels, the Fish Inspection Regulations do not provide for an easy and informative nomenclature to describe fish products. Under existing regulations, surimi-based products must be labelled such that:

1. The common name must clearly identify the species used in the manufacture of the product and, if more than one species is used, the species names must appear in descending order of proportion by weight.
2. Special processes used in the manufacturing process must be declared, for example, mincing.
3. The "name of the product" shall not include a name for which compositional standards already exist in the regulations, for example, fish sticks, or a coined name such as "stix" which could be mistaken by consumers as being fish sticks; or a name used for other products now on the market and generally recognized by the consumer, for example, fish cakes; or a name used to resemble natural product forms, for example, claws, legs, tails or fillets since these are considered to be false and misleading in that the product is not an actual claw, leg, tail or fillet.
4. If naturally flavoured to resemble a species, they shall incorporate into the common name the expression "(naming the species simulated) flavoured (the name of the product)" and if it contains an artificial flavour or flavours derived from other than the species simulated, they shall incorporate into the common name the expression "Artificially (naming the species simulated) flavoured (the name of the product)."

As an example, a product made to simulate crab legs manufactured from minced pollock which incorporates artificial crab flavour may be labelled as "Artificially crab-flavoured minced pollock pieces". The

descriptive term "pieces" is used to describe the product, as opposed to using "legs" or "claws". It is important that coined names do not make use of words or expressions which might lead the consumer to conclude that the imitated or simulated product was the genuine food.

To allow greater labelling flexibility, consideration is being given to amending the regulations to provide labelling alternatives to processors and be more informative to consumers. Proposals which are being considered include the use of common names to describe the product as "Formulated XXX", "Simulated XXX", "Imitation XXX" or "Artificial XXX" where "XXX" represents the fish product to be simulated. The term "Formulated" would be allowed only on products containing meat from the species to be simulated. "Simulated" would be allowed on products not containing meat from the species to be simulated. "Imitation" and "Artificial" would be allowed on products whether they contain meat from the species to be simulated or not. Other proposals include use of the terms "XXX Alternates" or XXX Substitutes" to describe these products. The Department of Fisheries and Oceans is prepared to accept these or other names provided the terms are demonstrated to be acceptable to the industry, are meaningful to the consumer, and meet other federal agency and department regulatory requirements. It is also proposed that descriptive terms would be required on labels to declare the percentage of meat from the species to be simulated when such is used. In addition, when no meat from the species to be simulated is used, the percentage of fish shall be declared. In either case, the presence fo natural or artificial flavour must be indicated, and should the use of texturized vegetable protein (T.V.P.) be permitted in Canada, its use and percentage content must be declared.

It has also been recommended, to ensure a clear understanding of the label by the consumers, that amendments to the regulations include:

- the coined name will appear in letters not more than twice the size of the letters in the common name;
- the descriptive terms will appear in letters not more than half the size of the letters in the common name, and not less that 1.6 mm (1/16th of an inch); and
- the coined name, the common name and the descriptive term(s) will appear in close proximity to each other.

Some examples are provided to demonstrate the proposed labelling changes.

Example 1:
Natural Flavoured Formulated Crab Claws
Contains 25% Crab Meat

Example 2:
Natural Flavoured Imitation Crab Claws
Contains 25% Crab Meat

Example 3:
Artificial Flavoured Simulated Crab Claws
Contains 60% Fish Content

Example 4:
Natural Flavoured Imitation Crab Claws
Contains 60% Fish Content

Examples 1 and 2 demonstrate that processors who incorporate a percentage of natural crab meat into their product may declare the percentage used on the label. It is questionable whether simulated crab meat, to which is added a substantial portion of natural crab meat, can be produced economically or whether such products are even equal in quality to products produced entirely from a cod or pollock protein base. The addition of crabmeat of poor quality to imitation

crab legs could downgrade the quality of the product[5] and substantially add to the processing costs. The approval of labels such as examples 1 and 2, must be approached with caution, since declaration of the percentage of crab may be a marketing ploy used by unscrupulous processors or importers since they know that objective testing methods are not available to accurately determine the amount of the natural species present.

Regulatory Control of Surimi-Based Products in the United States

A flood of surimi-based products into the United States led the U.S. Food and Drug Administration (F.D.A.) to react to the numerous labelling irregularities which were being encountered contrary to the Federal Food, Drug and Cosmetic Act which regulates these products. Section 403(c) of the Act states that a food is misbranded "if it is an imitation of another food, unless the label bears, in type size of uniform size and prominence, the word 'imitation' and immediately thereafter, the name of the food imitated". It also states under Section 403(i)(1) that a nonstandardized food is misbranded unless the label of the food bears the "Common or used name if any there be". Additional regulation promulgated under 21 CFR 101.3(e) states that "a food shall be deemed to be an imitation and thus subject to the requirements of Section 403(c) of the Act if it is a substitute for and resembles another food but is nutritionally inferior to that food".

Guidelines issued in the Import Alert advised all F.D.A. District Offices, in November 1984, to check imported products for proper labelling and not to take action if the product is labelled as "imitation" and the label states what the product is (e.g., "artificially crab flavoured pollock, a blend of____% pollock and ____% snow crab meat".). The alert advised that a compliance policy guide

was being prepared regarding the labelling requirements for imitation seafood.

National Fisheries Marine Service and several trade associations co-operated with F.D.A. by providing information regarding the manufacture and promotion of these products. This led to the release, in June 1985, of a Compliance Policy Guide on Processed and/or Blended Seafood Products. This policy is stated as follows:

1. If the surimi-based product purports to be or is represented as any specific type of natural seafood, including shape or from representations, but is nutritionally inferior to that seafood, it must be labelled as **imitation**. To date, F.D.A. has not encountered any surimi-based product in which nutritional equivalency has been achieved.
2. An additional statement of product identity must appear on the principal display panel such as "A Blend of Fish with_____". The blank is to be filled in with the common or usual name of the ingredient or component, such as "snow crab". Because the fish used in the surimi base has been decharacterized, the word "fish" is adequate for the statement of product identity. If an artificial flavour or colour is added, the label must comply with 21 CFR 101.22.
3. The specific names of all seafoods used in the product shall appear in the ingredient statement in descending order of predominance ("pollock" must be used as opposed to "white fish"; "snow crab" rather than "crab"). All other ingredients present must also be declared in descending order of predominance.
   Note: The intermediate surimi product usually contains sugar and/or sorbitol and phosphate compounds as cryoprotectants. These should be listed in the ingredient statement unless removed during the manufacturing process.
4. Products that are not purported or represented to be a specific type of seafood or seafood body part, need not be labelled

imitation, but may be marketed if the label properly reflects their composition.

5. Labelling of surimi-based products may suggest use in recipes in place of the natural seafood products by a generalized statement such as, "use like crabmeat, lobster, or shrimp in all seafood recipes," or a similar statement.

It is interesting to note that F.D.A. has permitted some flexibility in the labelling of surimi-based seafood products. An important admission is noted by the fact that the word "fish" is adequate for the statement of product identity and the labelling by percentage crab content, for example, is replaced with the statement "A Blend of Fish with Snow Crab".

The New England Fisheries Foundation with the co-operation of National Fisheries Marine Service undertook to review labelling issues as they relate to surimi production and to develop definitive guidelines for labelling and nomenclature for surimi-based products. The Brand Group of Chicago, Illinois, a consulting company familiar with seafood labelling, undertook this study. The study[6] concluded that the term "imitation" on a label may have negative side effects because of consumers' perception that the word suggested an artificial, highly processed product not made from natural ingredients. It was suggested that the terms "alternatives" or "substitutes" might be more useable descriptors of surimi-based products. The study concluded, since there did not appear to be a viable alternative to the "imitation" labelling reuqirement, that a proposed identity system be used in addition to the term "imitation". The Brand Group felt that this combination would lessen any negative effects which the term "imitation" might have, and "provide consumers with information about the nature of the product".

In this regard, the National Fisheries Institute (N.F.I.), a U.S. national trade association whose members represent all aspects of the

fish producing, processing and marketing industry in the United States, is currently reviewing several options with F.D.A. which may eventually lead to the removal of "imitation" from the label of surimi-based products. The greatest obstacle is to provide proof of nutritional equivalency to F.D.A. for those products which are being simulated. It appears that surimi-based products which simulate a particular finfish or shellfish is not nutritionally equivalent because protein and other nutrients are lower than the products being imitated. Investigations are now underway to explore the technological feasibility of fortifying imitated products to achieve nutritional equivalency.

The N.F.I. is also exploring options for a "common and usual name" for surimi-based products. "Surimi Seafood" has been suggested as one name for this product. In addition to the common or usual name, the product is required to be identified with a characterizing statement which would meet F.D.A. requirements. Petitioning F.D.A. for regulatory acceptance is a slow and cumbersome process. It is not expected that this acceptance will be achieved in the near future.

Options for Canadian Labelling Changes

Processors and consumers require a clear and concise nomenclature system to describe surimi-based products which is meaningful and readily understood. While the current proposed changes to the Fish Inspection Regulations provide more flexibility for the industry, it is unclear at this time whether the expanded format using a variety of terms such as formulated, simulated, imitation or artificial improves or further confuses the matter for the consumer or are even acceptable to the industry. Other issues which may eventually have to be addressed include whether the species of fish needs to be identified on the principal display panel, and whether percentage information on labels provides consumers with useful information or presents an opportunity for abuse by some sectors of the industry. Currently, no

methodology exists to accurately determine the percentage of natural shellfish content in simulated shellfish products. Under such circumstances, the Department would have to use the inspection services from another country to determine the accuracy of these statements on the label.

In light of the above concerns, a number of labelling issues need to be resolved and a long-term strategy defined to give clear direction to the industry. With this consideration in mind, the Department of Fisheries and Oceans will be publishing a communique, a form which allows opportunity for a wide cross-section of the industry and the public equal chance to provide comments on proposed regulatory changes. This communique will outline proposals for changes to the Fish Inspection Regulations to permit greater leeway in the labelling of surimi-based products. Circulation of the communique will be made to all trade associations, fish processors, brokers and importers, consumer associations and other federal departments and agencies. Following an appropriate period, the responses will be reviewed by departmental officials. If the responses received are not favourable, then another communique will be prepared to reflect the views and comments of the interested parties and re-issued for further comment. Eventually, the proposed regulations will be brought forward for publication in the Canada Gazette where, through the regulatory process, changes are made to the Fish Inspection Regulations to permit greater flexibility in surimi labelling.

Conclusion

Labelling and nomenclature issues should not be considered as serious constraints in the future development of the surimi industry in Canada. Government is prepared to change current regulations to provide the flexibility industry needs to promote and market its products. It is important that interested participants in the industry become involved

in the regulatory process. This is to ensure that their views are considered by government officials in making labelling decisions and in the provision of more meaningful and informative labels to the consumer.

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3RD QUESTION PERIOD

The whole issue of regulation of the surimi industry raised several outstanding issues:

- Combination of Species/Imports
- Blends (meat and fish)
- Aged Fish
- Labelling

1. Combination of Species: Although there are not many foreign fish products available in Atlantic Canada, concern was expressed about the accuracy of the labels on these products. Competitive surimi-based products imported into Canada are often labelled as containing simply "Pacific Whitefish" when they contain any number of species in combination e.g. cod, pollock, turbot, etc. Canadian processors feel at a disadvantage in being required under existing regulations to stipulate exact content, maintaining that this can confuse and discourage the potential consumer. Assurances were provided that where importers do not comply with Canadian regulations, and where violations are noted and reported, appropriate action can and will be taken to remedy the situation.

2. Blends (meat and fish): Processors also seemed to be in agreement that meat-fish blended products would be the next logical step in the development of a successful Canadian surimi industry. Blends represent such a new area of development that there has yet to be ample consideration of its implications in Canada. The U.S. has looked at the issue and has a model in place in Alaska. That system will likely serve as precedent for a similar approach to be adopted in this country in the not too distant future.

3. Aged Fish: Partially decomposed (old) fish can be used to successfully and safely produce surimi i.e. surimi can be used as

a way to recover "old" fish, fish which would otherwise be wasted. Processors seem to favour a change in existing regulations to permit this, but were advised that such a change would be unlikely.

4. Labelling: Because a protein gel isn't a fish species i.e. because there is a de-characterization of species in surimi manufacture, some generic names for use on labels, as far as processors are concerned, seems to be warranted. New regulations will attempt to take such developments into consideration, but the challenge will lie in protecting the traditional levels of accuracy in labelling, while providing the flexibility to deal with the recent development of new and complex surimi-based products.

Dinner Address

by

Brenda Dunbar

Executive Vice-President

Canadian Association of Fish Exporters

I would like to add a few words based on my background - a marketing background. I've marketed a number of food products, working out of central Canada. Somehow along the way, I moved to eastern Canada and found this wonderful thing called the fish business. I had never encountered an industry quite like this before...for many reasons. I have been in and out of it for about 9 years but I keep coming back to it.

One thing about marketing that interests me is that marketing deals with people. You don't make products and you don't provide services unless there is a market for them. There are people out there who want something and you have to make them want what you have to sell. Certainly, people **are** the fish business. We are an international business and that makes it even more fascinating.

Several years ago, when I was here in Newfoundland, Dr. Ho knocked on my door and said he had these ideas. I thought they were kind of interesting. I don't know if anyone else was listening besides Frank (Slade) at the time, but we thought he had something interesting and we worked away at it. Cosmas did 99% of the work with the rest of us tagging along.

The thing about the fish business that is both a challenge, as I see it, and a major frustration is that it is clearly **not** market driven, in the true marketing sense. We are still largely a production oriented business - for many good reasons. When you don't know what raw material is going to come through your door on any particular day in

volume, etc., how can you begin to plan a marketing strategy around a production line? I think somebody coming down from Toronto or Montreal having been used to manufactured products like cigarettes, beer, cereal, or anything of that nature, simply can't cope with the mind-boggling nature of the fish business in that respect.

When we looked at something like surimi, one of the things that we found fascinating about it was the fact that you were taking a fish product and transforming it into a raw material which, assuming you had the raw material base in the first place, gave you an opportunity to take a product and run because you had something that you could transform into whatever you wanted it to be. This could be based on your definition of the market place and you could transform it by flavouring it and colouring it and doing all sorts of neat things to it that you couldn't do with any other product from the sea. In short, you could be a marketer. You could involve yourself with the food industry and other aspects of the business community that the fish business doesn't normally get very involved in.

When Cosmas knocked at my door, I was excited! Here we are 5 years later and I think Cosmas has been instrumental in getting us where we are in Atlantic Canada today. Many other people, of course, have made major contributions, to the point where we can have a group like this come together.

Usually in the fish business when people get together it's because they have a "bitch". Inshore versus offshore; somebody wants more of the lobster resource; unions fighting the processor or something else...often negative.

In this case we have a group of people who have come together on the technical side, trying to put a process in place in Atlantic Canada that involves an interesting marketing opportunity. To date we have

only one processor in the Region who is actively involved, but I think we all see potential to take something that is currently not in our hands or that we are throwing away and transforming it into a food product, being good marketers, and making money at the same time.

I see this as being a very positive experience, a unique kind of experience in the marketing context of the fish business. Canada, despite the fact that it will export over 2 billion dollars worth of fish this year, remains largely a seller of fish. Most of that increase, because it's only been a few years since we sold only 1 billion dollars worth of fish outside the country, came largely in the last year because of currency exchange rates. Clearly, there has been very little growth in sales volume. Most of the extra dollars have come in because of the favorable currency rate. We were in the right place at the right time and we had product. We didn't go out and market it. I think that even though people might flash big numbers in front of you and make Canada sound like we are number one, which we are in some respects, we still have a long way to go.

I think that as we involve more processors in the surimi experience, we can begin to transform our way of looking at the resource. We can try to maximize the yield from the resource that is available, and to find a market niche for products that we have thrown away or that we have not been interested in. Some of the processors, who are a little smarter than the others, are the ones who will pick up on it first.

All in all, I see the surimi experience as being very positive, wherever we end up. I think that, certainly, we are going to face more competition. I don't know exactly what's going on, but I know the Japanese, besides talking to the New Zealanders and Chileans, are talking to the North Koreans and the Chinese, and there are many countries (the Danes, of course, and others in Europe) who regard this as a real market opportunity. We are going to have to be smart because

everybody has got their eyes focused on that U.S. market, and Canada is going to have to determine what part of the market it wants and go after it very aggressively.

Of course, we all know that in the fish business people by and large haven't spent money trying to get a piece of the market. As Sharon (Gwinn) pointed out today, the low level of advertising expenditures point out a problem in the industry. People just don't invest in the market because they see themselves being in the market today and probably not tomorrow, unless the price is right. Surimi, again, is a little different in that, if you are manufacturing the product and you are going to be there tomorrow, you have got to be far more sophisticated in the way you do business in order to survive the competition.

I personally would like to thank all of the people involved in organizing this event because I think they have brought together a very interesting group of people, and I think tomorrow will be another day of learning. That this sort of thing must continue so that we'll continue to build up our expertise in Atlantic Canada and get out there, make some good products, sell them and make money at it.

Producer's Perspective: Problems vs. Opportunities

by

Dr. Cosmas Ho

Terra Nova Fishery Co. Ltd.

We began keeping an eye on the Surimi situation in 1981, and in 1983 Terra Nova Fishery Co. Ltd. began serious planning. By July 1984, we were into commercial production of surimi and crab analogs. We are the first Canadian Company to produce surimi commercially, the first in the world to produce surimi from codfish, and the first in North America to make both surimi and crab analogs in the same production unit.

If you asked me today how I feel about our program, I guess I would have to say I have a lot of mixed feelings. In the beginning I was very enthusiastic about it. We all worked very hard, had a lot of headaches, a lot of problems and a lot of frustrations and disappointments. However, we learned a lot and also made quite a few new friends. But the bottom line is that I enjoy it, and we have enough money to repay the bank!

Today I am going to outline some of the problems we have faced since the beginning of our surimi project and also some of the opportunities that lie in the future.

I recall one of the first problems we faced, and still face at times, Newfoundland's isolation. Because of the highly technical nature of the surimi industry, we required a lot of infrastructure support services which were not available to us. As an example, we ordered an electrical panel from Ontario in February 1984 with a 4-week delivery date. Shortly after that, we went to Japan to see the surimi equipment manufacturer. After our inspection of various equipment and making sure everything was in order, the manufacturer put together a package for us and made arrangements to ship everything by marine transport.

In late April, 1984 the equipment arrived in Newfoundland. About the same time, seven Japanese technicians arrived to set up the equipment. Everything was assembled and waiting for electrical connection and the panel which was ordered from Ontario in February had still not arrived! The delay was caused by "manufacturing problems as well as transportation problems".

Meanwhile, the equipment which came from Japan had to be modified considerably to suit our needs. Motors had to be changed to meet Canadian standards, which differed from those of the Japanese. The propane safety system had to be modified. The steam boiler standards dictated changes. So you can see, there was a lot of work and much frustration. However, by the time equipment was finally assembled to meet regulatory standards, we were ready for production.

Actual manufacturing technique was changed and improved because of the "condition" and properties of the raw material we were using. You must remember that this equipment was manufactured, and processing technique in Japan was geared for using pollack as the raw material and we were using cod. These species have different properties, a fact which is extremely important in the surimi process.

I remember an occasion about two years ago when we had about 40,000 pounds of cod fillet left on our floor and our equipment was not working adequately because, believe it or not, the fish was **too fresh!** Our dehydrator had to be modified to overcome "the problem". Basically, we were going through growing pains in our day-to-day operation and we still are, even now.

Another problem we are faced with is adequate water supply. Our plant was drawing enormous quantities of water from the local Clarenville system, as much as half the available supply at times! Since we began our surimi operation, the town has increased its pumping capacity

twice. Our water consumption is about 140,000 gallons per day. We also have an ongoing problem with recovering the effluent from our operation. We are continuing to work on a more efficient recovery system for the waste water and, of course, at the same time, trying to increase our yield.

In the very beginning, we were importing our ingredients from Japan. Every item used to make our crab analogs, from the crab extracts and flavours right down to the starches, were imported. Trying to find out the ingredients from the Japanese suppliers was one thing, having them approved for use in Canada was another, and trying to win a 17 1/2% import duty argument with Revenue Canada was something else! We have come a long way!!

We gradually, bit by bit, with a lot of hard work and determination, were able to identify North American suppliers who could eventually develop replacements for the Japanese ingredients. We have learned all about amino acids, neucleotides and the different properties of starches. We now have our own formula, with all of the ingredients coming from North American sources. But I have to say, it is possible that some of the components of these ingredients still come from Japan. We feel very happy to have solved our ingredient problems and to have secured North American suppliers, and well we should. On our last enquiry to Japan, we learned that ingredient prices had increased by 150%!

Marketing problems... Unfair competition...

Maybe some of you already know that during the first year of commercial production, we had a very good marketing outlet. We had been approached very aggressively by several large food companies looking for exclusive rights to our product line. Unfortunately, the one we

selected has proven not to be our best choice because they did not have a frozen product line nor a seafood line prior to ours. Indeed, they purchased our entire production and inventory for a whole year, but, unfortunately, they sat on it in a Montreal warehouse for almost a year. That one-year delay in not getting our product on the retail shelves allowed the Japanese to move very aggressively into the Canadian marketplace.

To go back a step... we had to work very closely with the Federal authorities regarding labelling procedures for this "new" type of product. Meanwhile, the Japanese were importing product that had misleading labels. As an example, their labels read 35% crab meat content, when in fact, this was not possible, technically or economically. This problem still exists today. I understand that imported products are under constant investigation by our authorities, and it is becoming more and more difficult to import these products (particularly into the U.S.). We have seen the crab meat content according to the labels on imported products decline from 40% to 30% and, now, down to 10%!

Our first year of production, we were required to label our product as "imitation". The second year, however, the word "imitation" was not allowed to be used any longer. We had to revise our package design to reflect the new changes in regulations which now obligated us to label our product "crab flavored minced cod". We are still arguing the compulsory use of the word "minced" but, to date, it has been in vain! Believe it or not, the word "imitation" in labelling of such products destined for the U.S. is mandatory. So you can see, it is extremely confusing and time consuming. At the present time, we have to use different labelling for products sold in the U.S. and Canada.

Raw materials...

Yesterday, we discussed raw material availability in Newfoundland and we all know that three years ago Terra Nova Fishery intended to use trap cod, particularly under 18", for its surimi operation because it had virtually no value at the time and was usually dumped. Suddenly, the inshore fishery in Newfoundland was in trouble and it caused an extreme shortage of raw material. This year we made very little surimi and had to depend on inventory from last year's surimi production for our crab analog production this year.

When you look back over all the problems I have outlined today, the outlook for surimi in Newfoundland looks very bleak, but, in my opinion, we've come a long way in the last few years. The overall picture is that Newfoundland is only making a beginning in the surimi industry. There is plenty of opportunity with surimi in the future.

Opportunities...

As I have outlined, we have ironed out most of the bugs in our equipment, replaced Japanese ingredients in our products and, thanks to DFO and NRC, have research teams in place in the Atlantic Provinces to support the industry. As far as raw material problems are concerned, I personally feel the inshore fishery will improve. Historically in Newfoundland, the trapfish season has always seen a surplus of fish, especially when capelin season is upon us and when the capelin market is good. If, however, codfish remains in short supply, other whitefish, such as silver hake and grenadier, are available. Suitability of these species has already been determined, however, methods of catching, etc., have yet to be resolved.

All of my previous comments have been directed towards white-meat surimi which is used mainly for shellfish analogs; however, I see great potential for utilizing other species such as male capelin, herring and mackerel, etc. to make darker meat surimi. This would be a good time to look at separating fish oils from these species to obtain the valuable Omega 3 fatty acid. The following are some of the applications for surimi, based on its different functional properties:

- shellfish analogs
- fish cakes and fish sausage
- protein binders and ice cream fillers
- soup bases
- skin moisturizing creams

It can be used in simulated red meats and cheeses, baby foods, protein drinks and in the formulation of breads and pastas.

Because surimi itself is an excellent functional protein, it has almost unlimited applications. Surimi came to North America only a short while ago, and we have seen the market growth in shellfish analogs double each year for the past 5 or 6 years. (From 6 million pounds in 1981 to 120 million pounds in 1986!)

In closing, surimi is a heavily research-and-development oriented industry compared with the traditional fish processing industry. It takes a lot of time, costs a lot of money and requires a lot of dedication and courage. The surimi industry is only in its infancy in Newfoundland. It is only with considerable foresight in setting the right direction and with the co-operation of all sectors of the industry that it will work.

I sincerely hope that in the next surimi workshop, I have more good news to share with you!

DISCUSSION GROUPS

The second half of the final session of the Surimi Workshop was devoted to discussion by five sub-groups (Appendix E) using as a focus document a questionnaire provided by the organizers (see below).

ATLANTIC CANADA SURIMI WORKSHOP
CLARENVILLE, NEWFOUNDLAND
JANUARY 28-30, 1987
TOPICS FOR DISCUSSION AND RANKING

1. Where should surimi related research and development efforts be directed in the future?

   In the left hand column list research areas in order of priority (1-highest priority, 6-lowest priority)

COMMENTS IN THE SPACE PROVIDED PLEASE:

___ A. Impact of various raw material handling/holding procedures on surimi quality/yields?

___ B. Equipment improvement and development of optimum processing procedures and controls for various types of raw material eg. groundfish frames, fatty/oily species (pelagic), etc.

___ C. Product development work to determine the potential use of surimi (especially coloured surimi) in products other than seafood analogs?

___ D. Continue efforts with respect to flavour development?

___ E. Identify and minimize the environmental impact of a surimi industry?

___ F. Clarification of regulatory requirement?

2. What role, if any, should government play in the commercialization of a surimi-based industry?

COMMENTS:

_____ A. Provincial Government?

_____ B. Federal Government?

3. Additional Comments/Recommendations.

Question 1 (R & D): -

With one notable exception, consensus seemed to centre around the advancement of processing technology as a first priority. Perhaps because of the stage of evolution at which the industry finds itself, the closely related alternatives of product development and additional raw material research were ranked second and third in priority as the industry now shifts its attention from surimi itself to surimi-based products. The successful production of both requires the use of flavourings, and the groups ranked this work as next in importance. An exception here, as already noted, was Group 4, chaired by Mike Voigt of the Biochemistry Department at Memorial University which ranked flavouring as its first priority. Such things are often a matter of perception, and that's as it should be. At the bottom of everybody's list, but still considered important in the overall scheme of things, were regulations and environmental impact.

And so, from a quick review of the questionnaires, a clear pattern concerning the future direction of surimi-related research and development emerges.

Research Priorities by Group
(Questionnaire)

OPTION	RAW MATERIALS A	PROCESSING TECHNOLOGY B	PRODUCT DEVELOPMENT C	FLAVOURING D	ENVIRONMENTAL IMPACT E	REGULATIONS F
Group 1	3	2	1	4	6	5
2	3	1	2	6	5	4
3	2	1	3	4	5	6
4	2	3	5	1	4	6
5	3	1	2	4	5	6

Question 2:

The working groups found it somewhat difficult to elaborate separate roles for the federal and provincial governments in the future development of an Atlantic Surimi industry. What's clear is that a highly cooperative approach to development must evolve which eliminates duplication of effort, makes maximum use of scarce resources and yet "covers all the bases". Basically, covering the bases means dealing effectively and comprehensively with the priorities established in Question 1, i.e., government should ensure that certain things happen, albeit, as one group suggested, with the aid of an advisory committee, to help ensure proper direction.

The groups did articulate a slightly broader definition for several of the key components of a surimi development strategy:

- R & D was expanded to include stock assessment and management; harvesting technology and economics; and processing methods and technology.

- product development, it was felt, should include a stronger marketing orientation (i.e., the surimi industry should be market driven).

- technology transfer and industrial training should go hand-in-hand -- both will be required of government in future.

- regulations, particularly in regard to labelling, should evolve as rapidly as the industry develops. Future regulation of the industry will require initiative, imagination, and cooperation at all levels.

- a coordinating committee (similar to the group already established in the Newfoundland Region) is needed to act as a clearing house for all surimi-related activity and should be established on an

Atlantic-wide basis. A secondary benefit would be that the group could keep those interested and involved up-to-date on all current activity in the field.

Question 3 - Other Comments:

One group felt the need to create a controlled or "limited entry" surimi industry to ensure orderly development. Market saturation was a major concern to the delegates who felt this way.

Another group voiced the conviction that there should be an even greater industry (versus government and institutional) presence at subsequent workshops, forums, meetings, etc. Striking an appropriate balance — government, industry and institutional — is at issue here, as it is in all areas of surimi-related activity.

CHAIRMAN'S CLOSING REMARKS - FRANK SLADE

By now, there should be no doubt in anyone's mind about the tremendous potential available to us in surimi. But it should also be clear that achieving this potential will not be without difficulties. Our presenters have given you the "good news" and the "bad news" and provided the information and insight you will need to make correct decisions in the future.

Sharon Gwinn indicated that market trends are positive - there are great opportunities, but they will require imagination and effort on our part if we are to capitalize on them.

Geir Sobstad told us that Japanese domination of the industry can be challenged technologically. We can design and build a new generation of equipment that will allow us to compete effectively in the marketplace.

Max Grandy confirmed that there are large volumes of available raw material at our disposal to support an Atlantic surimi industry. We simply have to harvest and process these species more efficiently and that means using proper technology and developing the required expertise.

Chandra Chinniah showed us that we already possess the know-how and technology to hold our own against the competition. Our products can measure up to the demands of the market at home and abroad.

Dick Whitaker spoke of the importance of maximizing yields from available species and about the proven methods we have of doing so, even at this early stage in the development of our industry.

Dr. Richard Ablett's address illustrated the importance of R & D work currently being conducted in our universities and technical institutes. They must lead the way into the future through successful product and process development.

Mike Hawco and Ernie Reimer told us of the need for effective process control. With surimi, process is everything. Our surimi will be only as good as the production process we use to produce it. We can control and improve that process, if we really decide to get serious about it.

Dr. Mike Voigt talked about the importance of proper flavoring and the work that is being done in this area. He had quite a shopping list of the kinds of things that will have to be done to guarantee success in the future - it will require firm commitment on our part to see this work through to completion.

Bob Mills really had the hot-seat yesterday. His assurances that regulations affecting the surimi industry are slated for review and that industry input will be welcomed seemed to address your concerns about labelling and inspection.

Brenda Dunbar really came through in the crunch (Deputy Minister of Fisheries - Newfoundland - Ray Andrews, was unable to attend the Workshop) and had an important message. This industry will have, in future, to be market driven - something we often overlook - if we are to wrestle a decent market share away from the Japanese and other competitors.

Finally, Dr. Ho showed what can be done and how tough it can be to do it. His leadership and example is something we can all relate to. We will have to be just as determined, just as astute and just as innovative, if we are to share in his success. His assurance that

there is plenty of room for everybody in a market of this size was perhaps the "best news" of all.

Special appreciation goes to:
Michelle Thompson and MUN Extension for a great organizing job; hotel staff at the Holiday Inn for their hospitality (and to Manager, Russell Fudge for the screech-in ceremony); and to you participants for being here to make this workshop such a success. Have a safe trip home. Thank you.

APPENDIX A

AGENDA

WEDNESDAY, JANUARY 28, 1987

1:00 p.m.	**WORKSHOP REGISTRATION**
2:00 p.m. to 5:00 p.m.	**SURIMI PLANT TOURS**
7:30 p.m. to 9:00 p.m.	**RECEPTION**

THURSDAY, JANUARY 29, 1987

8:30 a.m.	**LATE REGISTRATION**
9:00 a.m.	**OFFICIAL OPENING—SURIMI IN ATLANTIC CANADA** **Frank Slade**, Department of Fisheries and Oceans
9:30 a.m.	**INTERNATIONAL PERSPECTIVE** (A) MARKET AND ECONOMIC SITUATION **Sharon Gwinn**, Acting Director, Alaska Fisheries Development Foundation
10:00 a.m.	(B) RECENT TECHNOLOGICAL ADVANCES **Geir Sobstad**, Alfa Laval
10:30 a.m.	**QUESTIONS AND ANSWERS**
10:45 a.m.	**COFFEE**
11:00 a.m.	**ATLANTIC CANADA—THE PRESENT SCENE** (A) RAW MATERIAL—AVAILABILITY **Max Grandy**, Senior Economic Analyst, Department of Fisheries and Oceans

11:30 a.m.	RAW MATERIAL—ACCEPTABILITY **Chandra Chinniah**, Surimi Project Manager, Institute of Fisheries and Marine Technology **Richard Whitaker**, Department Head, Institute of Fisheries and Marine Technology **Dr. Richard Ablett**, Assistant Professor, Technical University of Nova Scotia
12:30 p.m.	**LUNCH** (Buffet style, on your own)
2:00 p.m.	**ATLANTIC CANADA—THE PRESENT SCENE** (Continued) (B) PROCESSING CONCERNS ADEQUACY OF CURRENT PROCESSING TECHNOLOGY **Mike Hawco**, Staff Scientist, Canpolar Consultants **Dr. Ernest Reimer**, Vice President, Canpolar Consultants
2:40 p.m.	FLAVOR DEVELOPMENT FOR SEAFOOD PRODUCTS **Dr. Mike Voigt**, Professor, Memorial University of Newfoundland
3:00 p.m.	**QUESTIONS & ANSWERS**
3:15 p.m.	**COFFEE**
3:30 p.m.	**REGULATORY SITUATION** **Robert Mills**, Head, Fish and Fish Products Inspection, Department of Fisheries and Oceans
4:10 p.m.	**QUESTIONS AND ANSWERS**
4:40 p.m.	**REVIEW OF AGENDA** **Frank Slade**, Department of Fisheries and Oceans

5:00 p.m. to 7:30 p.m.	**FREE TIME**
7:30 p.m.	**CASH BAR**
8:00 p.m. to 9:30 p.m.	**BANQUET** Guest Speaker: **Brenda Dunbar,** Executive Vice President, Canadian Association of Fish Exporters

FRIDAY, JANUARY 30, 1987

9:00 a.m.	**PRODUCER'S PERSPECTIVE:** PROBLEMS VS. OPPORTUNITY **Dr. Cosmas Ho,** President, Terra Nova Fishery Co. Ltd.
10:00 a.m.	**COFFEE**
10:15 a.m.	**CONCURRENT DISCUSSION GROUPS:** RECOMMENDATIONS FOR FUTURE DIRECTION
11:45 a.m.	**PLENARY REPORTS ON RECOMMENDATIONS**
12:15 p.m.	**CHAIRPERSON'S SUMMARY AND WRAP-UP** **Frank Slade,** Department of Fisheries and Oceans
12:30 p.m.	**CLOSING**

Organizational Services
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School of Continuing Studies and Extension
Memorial University of Newfoundland

TERRA NOVA FISHERY COMPANY LTD.
CLARENVILLE, NEWFOUNDLAND

Terra Nova Fishery Company Limited was founded in 1979 by Dr. Cosmas Ho, a medical doctor in Newfoundland. Initially the company processed dried squid for export. Secondary processing of groundfish products soon followed. The company continues to be involved in groundfish processing.

Surimi production began in July 1984 with the production of imitation crab meat in the form of crab sticks.

Surimi itself is a tasteless, odorless product made from the minced, washed muscle of the fish. Flavorings are added to simulate the desired crab product.

Terra Nova Fishery's surimi operation is the only plant of its type in Canada and is the only operation in the world to use cod as the main ingredient in the production of surimi.

The Clarenville plant uses modern Japanese technology. The maximum capacity of the plant is 5 tons of surimi per 8-hour shift.

APPENDIX C

ATLANTIC CANADA SURIMI WORKSHOP

JANUARY 28-30, 1987

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Resource People (left to right)): Geir Sobstad, Mike Hawco, Max Grandy, Richardd Whitaker, Robert Mills, Chinniah Chandra, Dr. Coosmas Ho, Sharon Gwinn, Dr. Richard Ablett, Dr. Mike Voigt. Missing: Dr. Ernest Reimer.

BIOGRAPHIES

Richard Francis Ablett

Richard Ablett, Ph.D., is assistant professor, Canadian Institute of Fisheries Technology and Department of Food Science and Technology (1986), Technical University of Nova Scotia, Halifax, Nova Scotia. His teaching has included courses in carbohydrates in food, principles of nutrition, advanced food chemistry, and fish/food processing. Recent industrial and consulting experience has covered such areas as development of "mussel in the half-shell" canned product; development of frozen "breaded mussel" product; and surimi manufacture Atlantic species. He is a member of the Institute of Food Technologists, Director Atlantic Region Canadian Institute of Food Science and Technology, and Secretary Aquaculture Association of Nova Scotia.

Vimala Chandra Chinniah

Vimala Chandra Chinniah, M.Sc., is project manager at the Newfoundland and Labrador Institute of Fisheries and Marine Technology, St. John's. He has been involved in the fishing industry in various capacities over the last nine years. His experience includes being plant manager, Foxtrap Seafoods Ltd.; technical advisor, Department of Fisheries; area control supervisor, National Sea Products Ltd.; and fisheries observer, Fisheries and Oceans Canada. In addition, he has planned, organized and implemented groundfish grading programs, improved buying practices of fish, especially at National Sea Products plants at Arnold's Cove and LaScie.

Brenda Dunbar

Brenda Dunbar is the Executive Vice President of the Canadian Association of Fish Exporters. She has two B.A. Degrees (Economics and Commerce) as well as a MBA from the University of Toronto. Having previously worked with the International Directorate at Fisheries and Oceans and with Regional Economic Expansion, Brenda possesses that ideal combination of education and experience for her current position in which she must often serve both the public and private sectors in her day-to-day activities.

Max Grandy

Max Grandy, B.Sc., B.A., is a Senior Economic Analyst with the Economics Branch of Fisheries and Oceans in St. John's. He has been with DFO since 1982. Prior to that he worked with the Newfoundland Department of Mines and Energy, Consumer and Corporate Affairs Canada, and Agriculture Canada.

Sharon Gwinn

Sharon Gwinn is President and owner of First Alaska Surimi, Inc., at Seattle-based company providing technical services to the seafood industry, specializing in development of new fishery products. Ms. Gwinn is also, at present (until March 1987), the Acting Executive Director of the Alaska Fisheries Development Foundation. AFDF plans, sponsors, and manages research and development projects designed to foster the growth and diversification of Alaska's seafood industry. BEfore establishing First Alaska Surimi in 1985, Ms. Gwinn served as the Foundation's Program Director for five years, during which that organization made Alaska surimi production a reality. Ms. Gwinn was educated as a biologist, and holds a bachelor's degree from Wellesley College and a master's degree from the University of California.

Michael W. Hawco

Michael Hawco, M.Sc. is a doctoral candidate in food science at Memorial University where he is involved in an investigation of the post-mortem changes which occur in iced cod and how they affect the production of surimi. Since 1984, he has worked as a research scientist with CANPOLAR Consultants Ltd. There he is responsible for the design, implementation and reporting of various literature/field studies. His work has included an investigation of biochemical and chemical indices; verification of a hand-held fish color grading device--COLORMET (TM); an investigation of optical and electronic methods of moisture determination in fish; and also an investigation of possible techniques for the detection of parasites in fish flesh.

Cosmas V. Ho

Cosmas Ho, M.D., is President, Terra Nova Fishery Co. Ltd., Clarenville, Newfoundland. Since 1965 he has carried on a full-time medical practice of Family Medicine at St. John's, Newfoundland. He is a member of the Chinese Acupuncture Institute, Hong Kong certification.

Robert E. Mills

Robert Mills, B.S., joined the Department of Fisheries in 1968 and has worked with the Fish Inspection Laboratory as a Fish Quality Specialist in the canned and prepared fish product section. He is now Head, Fish and Fish Product Inspection, with responsibilities for co-ordinating and administering the enforcement and regulatory requirements for the inspection of fish products in the Newfoundland Region. Mr. Mills has served on a number of national committees for the development of various grade standards and has represented Canada at several sessions of the Codex Alimentarius Commission.

Ernest Michael Reimer

Ernest Reimer, Ph.D., is Vice-President, CANPOLAR Consultants Ltd., St. John's, Newfoundland. Before working with CANPOLAR, from 1979-83 Dr. Reimer worked with the Centre for Cold Oceans Resources (C-CORE) at Memorial University. At CANPOLAR, he is responsible for the management of projects including innovation, systems design and fabrication of intelligent sensing systems. His corporate responsibilities are strategic planning and administration. He is a member of the Institute of Electrical and Electronic Engineers, and the Canadian Institute of Food Science and Technology.

Frank Slade

Frank Slade, B.Sc., is Director of Harbours and Infrastructure, Fisheries and Oceans Canada, St. John's, Newfoundland. He joined the Federal Department of Fisheries in 1963 as a Fishery Officer. In 1970, he was appointed Fish Inspection Supervisor for the West Coast of Newfoundland and in 1973, he moved to St. John's as Associate Chief of Inspection. In 1984, he became Director of the Fisheries Development Branch Newfoundland Region until he was appointed to his present post in 1986.

Geir Soebstad

Geir Soebstad is a process development engineer specializing in marketing with Alfa Laval. He's a graduate of the University of Berger in Norway with a Master's Degree in Science. He started in the fish business 15 years ago and joined Alfa Laval at their Swedish office in 1985. Alfa Laval is a fish and meat engineering company headquartered in Soborg, Denmark with offices located around the world, including Montreal and Toronto. In the early 1980's, the company began trials with decanter centrifuges in an Alaskan Surimi plant. They were successful in developing a complete surimi line introducing a single stage wash system, replacing the 2 and 3 stage conventional screen wash system in use throughout the industry.

Michael M. Voigt

Michael Voigt, Ph.D., is an assistant professor, Department of Biochemistry, Memorial University, St. John's, Newfoundland. He has had considerable experience in the food processing industry and has taught courses in food microbiology, meat processing, food chemistry, food preservation, and food analysis. Currently, he provides lectures and laboratories for four of the nine core courses in the Food Science program at Memorial and also provides laboratory services to the food industry. He is a member of the Institute of Food Technologists, the Canadian Institute of Food Science and Technology, and the Canadian Society for Nutritional Sciences.

Richard S. Whitaker

Richard Whitaker, B.Sc., Ag., is Head, Department of Food Technology, Newfoundland and Labrador Institute of Fisheries and Marine Technology, St. John's, Newfoundland, where he has worked for the last 17 years. He has been instrumental in gearing the department to respond to various phases of fishery development. He has provided a variety of training programs for quality control, supervisors, specific processes such as canning, smoking, skill training and diploma programs. He has supervised delivery of N.R.C. assistance to industry programs which have solved a number of industrial problems and developed new products. In 1984-85, Mr. Whitaker supervised a surimi industrial survey contract with DFO.

APPENDIX D

ATLANTIC CANADA SURIMI WORKSHOP

JANUARY 28 -30, 1987

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APPENDIX E

ATLANTIC CANADA SURIMI WORKSHOP

DISCUSSION GROUPSS

GROUP I

Nancy Wilson
Richard Ablett
Bob Bourdage
Noel Despres
David Ho
John Holme
Frank McKinney
Eugene Trickett
Kevin Way
Larry Yetman
Murray Chaplin
Kirk Loveys

GROUP II

Ernest Reimer
Gaston Berthiaume
Nigel Allan
Max Grandy
David Healey
Derrick Philpott
Charlie Moores
William Reardon
Jan Spinney
Connla Wood
Bernice Higdon
Richard Whitaker
Kathy Spencer

GROUP III

Andrew Duthie
Les Louttit
William Balsom
Frank King
Bob Ford
Sharon Gwinn
Jim Tompkinson
Eugene Seymour
Peter Kean
David Younker
Brian Gillett

GROUP IV

Mike Voigt
Patricia Hearn
John Storr
Maurice Bernier
Chandra Chinniah
Brenda Dunbar
Baxter Simms
Andy Miller
Paul Morin
Valerie Ervin
Mike Warren

GROUP V

Dave Lemon
Roy Benson
Dave Bailey
Keith Torrie
Mike Keats
Mike Hawco
Cosmas Ho
Robert Mills
Catherine O'Brien
Geir Sobstad
Ed Wein
Yves Tournois

*First name on list is Chairperson for group.